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AMERICAN JOURNAL OF OPHTHALMOLOGY

Vol. 5 NOVEMBER, 1922 No. 11

INJURY TO CORNEA AND CONJUNCTIVA DUE TO FISH BILE.

FREDERICK H. VERHOEFF, A.M., M.D., and JONAS S. FRIEDENWALD, A.M., M.D.

BOSTON, MASS.

An allusion to the effect of fish bile on the eye is quoted from ancient literature, and a case of injury to the cornea and conjunctiva by this fluid is reported. Experiments with bile from fish and the ox showed that in the rabbit bile caused loss of corneal epithelium, but the permanent opacity developed in a patient seemed not to be a necessary result, being rather due to lead collyrium. Reported from the Massachusetts Charitable Eye and Ear Infirmary.

The road of science is a tortuous one, that twists and turns and not infrequently crosses some of the most ancient footpaths. We were, therefore, much interested to discover, when we had completed the studies that are the subject of this paper, that our ideas had been anticipated by an ancient observer some two thousand years ago. In the Book of Tobit (II, 9 and 10), the story is told how Tobias, the father, became blind thru getting some bird droppings in his eyes, and his eyes were covered with white films. But his son obtained some bile from a fish of the Tigris river and he (Book of Tobit XI, 10-13) "ran unto him, and took hold of his father; and he strake the gall on his father's eyes, saying, Be of good cheer, my father. But when his eyes began to smart, he rubbed them; and the white films scaled away from the corners of his eyes; and he saw his son, and fell upward on his neck."

In modern medical literature, however, we have found no record of such a procedure. We wish, therefore, to report the following case, together with some experiments on animals.

REPORT OF CASE.

S. D., fisherman, aged 26, while opening a codfish allowed some bile to spurt into his eye. He says it hurt and burned severely, but he did not wash it out for several minutes. Twenty-four hours later, he came to the Eye Clinic, having meanwhile used a weak solution of lead acetat as an eye wash. His eye was found to be markedly congested. The nasal half of the cornea was slightly hazy, its surface was denuded of epithelium and could readily be stained with fluorescein. The neighboring bulbar conjunctiva was swollen and congested, and also stained with fluorescein over a large area. There was marked photophobia and lacrimation. A boric acid —zinc sulphat collyrium was prescribed and he was allowed to go home.

He returned one month later, stating that the inflammation had rapidly subsided but complaining of some impairment of vision. Covering almost the whole nasal half of the cornea, there was a milky, sector shaped opacity, having its apex in the pupillary zone. Everywhere the opacity was covered by glistening epithelium. A false pterygium had formed at the limbus, and fine grayish bands of scar tissue extended a short distance into the conjunctiva about it. V. O.D. 20/30. V. O.S. 20/20+.

EXPERIMENTAL.

Being loath to believe that bile could so injure the cornea, we experimented on rabbits and found that both fresh fish bile and prepared ox bile (Fel bovis U.S.P.) readily denuded the cornea of its epithelium.

Experiments 1 and 2. A small drop of fish bile was placed, with the aid of a wire loop, on the cornea of a rabbit, the eye meanwhile being held open by a speculum. After 5–10 minutes there

was a slight haziness of the area touched by the bile. The epithelium became swollen, lost its luster, and could very easily be wiped off. Twenty-four hours later, the area appeared as a smooth, sharply outlined erosion which stained deeply with fluorescein. In another twenty-four hours, the area was entirely clear and completely grown over by epithelium. Not the slightest conjunctival reaction was produced, and no permanent opacity developed.

This experiment repeated with ox bile instead of fish bile, gave identical results.

Experiment 3. To obtain a conjunctival reaction in any way comparable to that of the case reported, we found it necessary to keep the rabbit's conjunctival sac flooded with bile for several minutes. There followed then, shortly, a marked chemosis of the conjunctiva with considerable congestion and some demonstrable loss of conjunctival epithelium, the corneal reaction being as described above, except that with this prolonged exposure a slight diffuse superficial corneal haze developed.

Experiment 4. We repeated the procedure of experiment 3 on another rabbit, but in addition washed the eye several times in the next twenty-four hours with a 2% solution of lead acetat. A very dense and permanent milky opacity developed.

DISCUSSION.

Our experiments would seem to show that whereas the primary injury in the case reported was due to bile, the permanent corneal opacity which developed resulted from the use of a lead acetat wash rather than from the bile itself.

With the demonstration that bile can remove the corneal epithelium without injuring the underlying stroma, certain possible therapeutic uses suggest themselves.

On account of its bactericidal and solvent properties, bile was long ago suggested for the treatment of ulcus serpens,* but owing to the fact that in this condition the organisms are lodged deep in the stroma quite beyond the reach of the bile, no favorable results were to be expected, nor were they obtained.

In the course of certain studies by one of us†, we attempted to discover any possible therapeutic value of the local application of bile in experimentally produced herpetic keratitis in rabbits. We inoculated, by scarification, both corneae of a rabbit, with the virus of herpes. Both inoculations were made at the same time, from the same source, and in a way which we had found to result quite constantly in an approximately equally severe affection of the two eyes. Twenty-four hours later, a cotton swab soaked in bile was gently rubbed along the whole streak of inoculation of one eye. This eye subsequently developed the characteristics of experimental herpetic keratitis to a much more severe degree, and with a much denser and larger resulting permanent opacity than did the control eye. We would, therefore, regard the use of bile in herpetic or dendritic keratitis as definitely contraindicated.

It remains to be seen whether or not bile could be helpfully used in certain special conditions, where it is desired to remove areas of diseased corneal epithelium without injuring the underlying stroma. Our experience with experimental herpetic keratitis would indicate, that before using bile in such cases, one should be very sure that there were no pathogenic organisms present ready to attack the injured or exposed cells.

The case reported, together with our experiments, furnishes a striking example of the well known dangers that lie in the use of lead eye washes. We feel strongly that these washes should be eliminated from ophthalmic therapeutics.

*See American Encyclopedia of Ophthalmology under "Bile."

†Friedenwald—to be reported elsewhere.

ENUCLEATION AND PROTHESIS.

DONALD J. LYLE, M.D.

CINCINNATI, OHIO.

The behavior of organic implants living or dead is here discussed, and a case reported in which it was considered best to remove the piece of cartilage that had been implanted in the orbit nine months before. In another case, there had been no unfavorable effects from such an implant after eighteen months. Read before the Cincinnati Ophthalmological Club, May 11, 1922.

Grafting and transplanting organic tissues, both autoplastic and heteroplastic, has been known and practiced for several centuries, but only in recent years has it been used universally and extensively. Still more recently, pieces of living or dead organic tissues have been used as inserts in the enucleated or eviscerated orbit to act as a prothesis.

Inert inorganic substances such as glass or gold, if tolerated, become encapsulated. Even then, after a variable period, they may be expelled by a local inflammation, or the thinning of the tissue wall between them and the artificial eye. Inclusions of dead or living organic tissues, once admitted, as a rule are not expelled. Under strictly aseptic conditions, living organic tissues, as free grafts (separated from their original blood and nerve supply) may continue to live as the same tissue in their new sphere. But, as a rule, all free grafts, possibly with the exception of skin grafts, die; in which event they act in the same manner as dead inserts. Large groups of animal cells are able to live for a time when separated from all connection with their vascular and nervous supply, but they usually die as nourishment cannot reach the center by imbibition.

	Percentage of Inorganic content	Percentage of Organic content	Calcium percentage of Inorganic content
Mammal bone	34.56%	65.44%	40.13%
Mammal cartilage	25.00 to 30.0%	1.5 to 2.2%	7.88%
Mammal muscle	20.8 to 20.5%	0.9 to 1.0%	0.04%
Mammal fat	0.04%	trace	trace

Tendon, muscle, fascia and fat grafting of living tissue is rarely successful, unless the blood and nerve supply is carefully preserved. Bone and cartilage grafts are said to unite readily; but I believe these tissues also die, as a rule, and it is their organic framework that maintains the size of the original insert without shrinkage. The process of new connective tissue in growth of this bone and cartilage goes on. Osteoclasts which are present break down the proteid substances and absorb them; while osteoblasts, possibly with the aid of the calcium on hand, build a new bony structure in the inorganic framework.

We find that all necrotic organic tissues have the tendency to attract and lay down calcareous and osseous material, whether it be dead transplants, phthisical eyes, sclerotic arteries, or tuberculous lungs. Magitot has found that dead organic tissues are adopted and young osseous cells are seen to appear in them, and in the course of time a bony framework results.

It would seem that two distinct advantages would accrue from the employment of those tissues having the highest calcium and inorganic content, in that calcium salts in abundance are at hand and a scaffolding on which to build is available.

The following shows the inorganic, organic, and calcium percentage of different mammal tissues:

From this it would appear that first bone, then cartilage, would be by far the best material to use, in that they have the highest inorganic and calcium content and are the least absorbable.

I wish to present three microphotographs of sections from a specimen of intercostal (hyalin) bovine cartilage implant.

When Dr. Ayres came home from

France after the war, he brought with him the ideas and technic of Dr. A. Magitot in the use of ox cartilage as a prothesis. He suggested that I try implanting this cartilage in some cases, to see what results I would get.

The cartilage used was taken from the sternum of a young ox, between the insertions of the ribs, and kept in 65 per cent alcohol. Magitot now keeps this tissue in 10 per cent formalin solution. At the time of use, the cartilage was steam sterilized and cut down to about one-half the size of the eye to be enucleated.

Fig. 1.—Normal intercostal bovine cartilage.

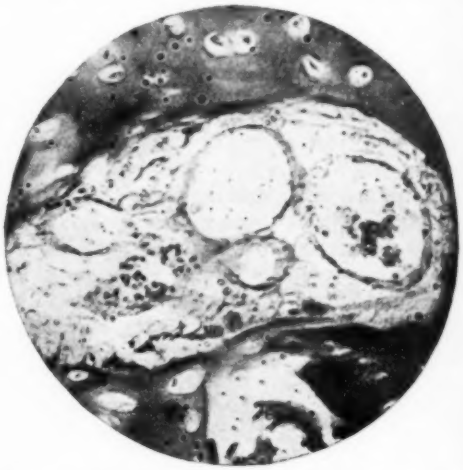

Fig. 2.—Showing group of blood vessels, necrotic cartilage and tissue invasion.

The microphotographs are all from the same piece of cartilage. The first one is of a part which was cut off at the time of operation. The second and third are pictures of a section of the cartilage removed from the orbit, nine months after its insertion at the time of enucleation.

This insert, after removal from the orbit, was sent to Dr. Austin of the pathologic department of the Cincinnati General Hospital for diagnosis. His report is as follows: "Specimen consists mainly of cartilage, for the most part uninjured, but showing connective tissue ingrowth with blood vessels, principally along one edge of speciment; a few small areas of bone formation are to be noted." Fig. 2.

This same section, along with the section of original cartilage, was examined by Drs. Malone, professor of histology of the Medical College of the University of Cincinnati, Goosman and Noonan, who concurred in the diagnosis of tissue necrosis with fibrous infiltration and beginning bony formation.

In the removed insert, four stages may be seen. First, the original unchanged cartilage; second, necrotic cartilage; third, calcification; fourth, signs of ossification. The tissue, had it remained, would probably in the course of a year turned thruout into true bone.

The advantages of the operation are as follows:

1. There is insured a better fixing point, presenting a convex instead of a concave or flat surface.

2. Muscle action, as a rule, is infinitely better.

3. There is less shrinkage of the orbital contents and retraction of the lids.

4. There is no interference with growth of the orbit in those who have not reached adult development.

Probably the only contraindication is sympathetic involvement of the opposite eye, and this is still a mooted point.

A word about the patient from whom the implant was taken may not be amiss. On May 27, 1917, while removing a towel from the branch of a tree, the branch sprung back, striking the patient across the face, leaving a thorn imbedded in his right eye. The

thorn was removed at the time, with no other treatment. Since then there has been rapid loss of vision in the right eye, with gradual loss in the left. When I saw him shortly before operation, the right eye was phthisical, with an opacity of the lens. The veins of the left eye were engorged somewhat, and the disc outline was rather indistinct. The pupil (left) reacted to light. The patient said that he had shooting pains thru the left eye at times, and the right eye pained him constantly.

Fig. 3.—Fibrous infiltration with beginning bone formation.

The right eye was enucleated January 29, 1921, and a piece of cartilage included in Tenon's capsule. The recti muscles were brought over the stump and united with catgut. The conjunctiva was brought together with a double purse-string of silk. Both eyes were bandaged for two days. There was very little reaction or swelling. The left eye ceased paining him, and the vision with a small cylinder was 20/20.

He returned again in the fall with pain in the left eye, and altho I could find no signs of trouble in the eye, I thought it best to remove the cartilage. This was done October 23, 1921, nine months after its insertion.

The removal of this cartilage was quite difficult, as it was bound down and penetrated by orbital tissue. It was held with a tenaculum and finally dissected out, more or less piecemeal. The removal of the insert took much longer than the entire enucleation and insertion operation.

The pain remained in the eye two or three weeks longer, and then gradually disappeared. When last I saw the patient, some two months ago, there was no pain in the left eye and vision remained 20/20.

Another one of these insertion cases, who has retained the cartilage for twenty-one months, is here for demonstration. This man was struck in the right eye with a bayonet while going under a tent in March, 1919. When I saw him, August 1, 1920, he was suffering very much from pain and headache. Examination showed a large staphyloma protruding from between the right eyelids, which included the cornea with the incarcerated iris and the lower outer segment of the eye. The left eye was negative in all respects. The enucleation and implant operation was done August 18, 1920, with the immediate cessation of all pain. The left eye since then has remained normal.

Five cases, two of which have been presented this evening, have been operated by me in this manner. So far as I know, these inserts have remained in place, practically unchanged in size. There has been no postoperative trouble of any kind. The recoveries have been rapid and uneventful. The cosmetic results are probably better than could be had with the simple enucleation operation.

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OBSERVATIONS IN A CASE OF LIPEMIA RETINALIS.

HUNTER H. MCGUIRE, M.D.

WINCHESTER, VA.

A case is reported in which the ophthalmoscopic appearances characterising this condition were under observation for more than three months, during which time they became normal. The accounts of cases previously reported are here referred to, and it is suggested that the condition is not so rare as the literature would indicate The vision usually remaining normal, no ophthalmoscopic examination is made Read before the American Ophthalmological Society, May, 1922.

The striking and unusual picture of lipemia retinalis and the comparative dearth of literature with regard to the subject, makes important the necessity for recording such cases when one has the good fortune to see them.

That the condition is rare is evident from the fact that only two papers, relative to the subject, have appeared in the Transactions of this Society; the first by Heyl in 1880, and the second by Hardy in 1921.

At the risk, therefore, of a repetition of some of the features of the paper by Hardy, whose opportunity for a complete metabolic study was so unusual, and for the purpose of showing the varying color changes in the vessels which I was permitted to watch for a longer period than has been the privilege of most observers, I desire to add to the records of this Society a case history in which it was possible to observe the color changes in the vessels for a period of three months, and to note the gradual return to normal as the fat content of the blood was reduced.

At the outset it should be stated that it was not possible, as was done in Hardy's case, to make a complete diagnostic study of the condition. The patient's mental attitude, particularly with respect to the medical profession, was such that no persuasion on my part could induce him to either enter a hospital or to take treatment; and he was not intelligent enough to carry out, at home, the usual dietary restrictions.

The changes to be described were, therefore, not influenced by any scientifically directed measures for the relief of the underlying condition, namely, diabetes mellitus. The case history is as follows:

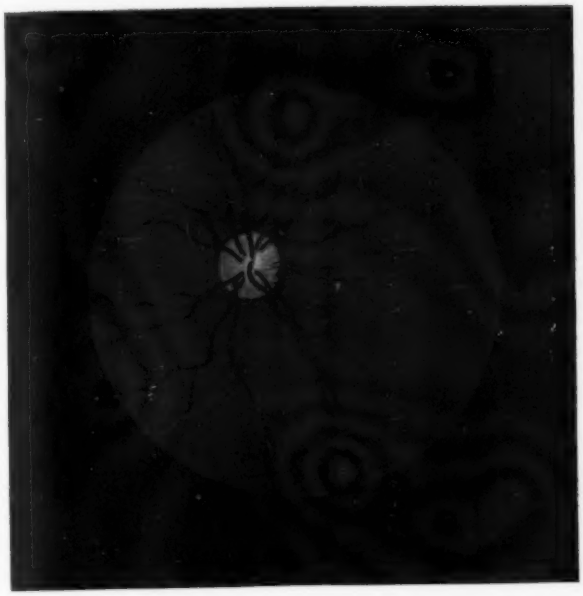
CASE. J. C. W., aged 33, was referred on November 10th, 1921, with request that an examination be made of the eyegrounds. The patient, an extremely emaciated, blond male, stated that up to the year 1919, when he developed diabetes, he had been free from any physical disability with the exception of a mild attack of gonorrhea during his younger days. He denied syphilitic infection.

He was drafted into service when the United States entered the world war, and passed the usual physical examination. Before being discharged, he developed diabetes and was sent to an army hospital at Ft. McHenry, where he remained for three weeks, leaving the institution because, as he expressed it, he "would rather die from the disease than be starved to death."

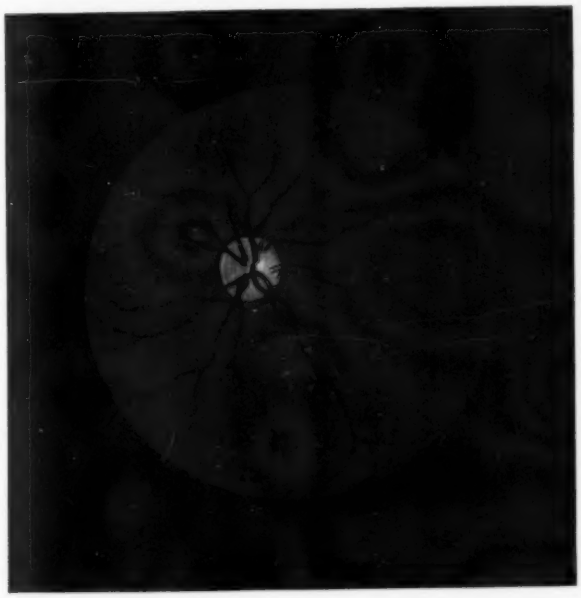
His present symptoms, the usual train indicative of the disease from which he is suffering, are weakness, loss of weight, thirst and hunger, polyuria, some cough and expectoration, and a few scattered skin lesions upon the extremities. He has no marked dimness of vision, but his eyes become easily fatigued when attempting to use them.

Ocular Examination: R.V. 20/XX—. L.V. 20/XX—. Pupils react to light and accommodation. There is no lack of balance in the external ocular muscles and no loss of accommodation. There is nothing suggestive about the lids or external ocular tunics, and there are no opacities in the lens. The tension is normal, the visual fields unaltered, and there are no scotomata.

Fundus Examination: The general color tone of the eyegrounds as a whole is of a much more decided pink hue than is usual, and there is some lack of pigmentation. The choroidal vessels are



ILLUSTRATING DR. HUNTER MCGUIRE'S CASE OF LIPAEMIA RETINALIS—COLOR SCHEME OF VESSELS WHEN PATIENT WAS FIRST EXAMINED.
FAT CONTENT OF BLOOD 8.6 PER CENT



ILLUSTRATING DR. HUNTER MCGUIRE'S CASE OF LIPAEMIA RETINALIS—COLOR SCHEME OF VESSELS TWO MONTHS AFTER FIRST EXAMINATION
FAT CONTENT OF BLOOD 3.7 PER CENT

not visible. All the retinal vessels, both main trunks and branches, contain a light salmon colored blood, with the exception of two fine vessels in the superior and inferior nasal quadrants. In these branches, as they extend to the periphery, the blood has assumed a deep cream tint. There are no distinguishing characteristics between arteries and veins, inasmuch as they all contain blood of precisely the same shade. The similarity of this color to the normal hue of the choroidal vessels is very striking. All of the vessels are of normal caliber and rotundity, there is no undue distention or tortuousity, and the central light streak is only faintly visible. Both discs are paler than normal and have a waxy appearance. There are no hemorrhages or exudates in either eyeground.

Blood Examination: The specimen when first withdrawn was very dark and of a purplish hue. Later, in a comparatively short time, there had been an emulsification of the oil globules, and the whole specimen took on a deep cream color with a few streaks of bright red thruout the cream like mass. The blood analysis is as follows: Wassermann negative. Nonprotein nitrogen 23 mg. per 100 c.c. Sugar 540 mg. per 100 c.c. Fat 8,600 mg. per 100 c.c.

Urinalysis: Specimen contains 5% sugar. Specific gravity 1034, trace of albumin, occasional hyalin cast, trace acetone, and no excess of indican. No record kept of quantity passed in 24 hours.

Course: From this period on, fundus examinations were continued at weekly intervals. The vessels were unaltered for a period of two weeks, but at the end of this time it was apparent that they were assuming a more normal color, and in the main trunks it was possible to differentiate the arteries from the veins. The cream color of the finer vessels on the nasal side, however, persisted to some extent tho a pinkish tinge was, apparently, being imparted to the cream. In eight weeks from the date of the first examination, the color tone of all the vessels was practically normal and the central light streak had reappeared. The color scheme remained unaltered until Feb. 10th, and since that time frequent observations have shown that the vessels are still normal.

In order to compare the fat content of the blood at a time when the vessels were normal with the percentage of fat found when the peculiar color existed, a second examination was made on January 17th. On this date the specimen contained 3,700 mg. of fat per 100 c.c. and 650 mg. of sugar per 100 c.c., showing a much lower percentage of fat and a somewhat higher percentage of sugar.

The percentage of sugar in the urine remained fairly constant thruout the whole period during which the observations were made.

With regard to the sugar content of the blood, it should be stated that the examination was not made until 24 hours after the specimen was withdrawn, and inasmuch as certain changes occur in its chemical constitution within four or five hours after the blood leaves the body, notably oxidation of sugar and uric acid, it is probable that the amount of sugar in the patient's blood was higher than the figure given in the report.

COMMENTS.

Lipemia retinalis is described as occurring in chronic alcoholism, phthisis, asphyxia, nephritis, phosphorus poisoning, pneumonia, gout and diabetes. In a careful search of the meager literature, I have been unable to find any case which was not associated with diabetes. Tho all of the recorded cases have been of diabetic origin, it is a noteworthy fact that the usual ocular lesions due to diabetes were not in evidence in a large majority of these patients. In Cohen's case, associated with hypotony, two recent small hemorrhages were observed on one eye, and in the case reported by Reis some lens changes were noted, but other observers have failed to record coexisting ocular lesions.

The extreme variation in the color tone of the vessels in lipemia retinalis, as described by various writers, is

probably due, in a great measure, as Hardy points out, to the amount of fat in the blood and the pigmentation of the fundus. On the other hand, it should be observed that the relationship between the color of the vessels and the percentage of fat is not a constant one. In Hardy's case, for example, the fat estimation was 9.5%, and the impression he gained from the appearance of the vessels is described as a flat toned grayish white, while in my patient the fat estimation was 8.6%, only a point lower than that of Hardy's case, and the predominating color was salmon red, and only in two of the finer vessels near the periphery could the cream color be detected.

In an attempt to explain the milky appearance of the retinal vessels in contradistinction to the normal appearance of the choroidal vessels in lipemia, Cohen has advanced the following hypothesis: "It seems possible that the milky color of the retinal vessels is not due solely to the chemicophysical state of the blood itself, but that in the readily flowing blood the red cells tend to congregate in the middle of the lumen of the vessels, so that the area at the edge of the lumen of the vessels instead of being clear is opaque, because of the lipoid bodies in the plasma. The milky color probably is not seen in the choroidal vessels because the rate of the blood current does not permit an observable separation of the lipoids from the red cells," the accelerated blood current in the choroidal vessels, being due, in his opinion, to the anatomic structure of the choroidal vessels with their wide arborization, anastomosis and extensive venous outflow.

While the majority of observers have recorded that the salmon red tint has been the predominating feature of their cases, others have shown that this peculiar tint is not entirely characteristic of the condition. In Heine's case, for example, all the vessels appeared as if they contained milk and not blood. Hale White describes both arteries and veins as showing a deep cream color, which in the large vessels passes into a pale salmon. Köllner, in whose case the fat estimation was 26%, thus records his observations: "From a dull background the retinal vessels stand out as reddish white streaks. They are much dilated but not sinuous. The tiniest ramifications of the vessels are visible as white threads." In the boy examined by Cohen, forty-eight hours before death, the retinal arteries and veins were similar in all respects, with a slight dilatation of the lumen. The color from the center to the periphery, namely, from the main trunk to the capillaries, was decidedly milky in appearance thruout, and the fat content of the blood was 8.95%.

With regard to the characteristics of the vascular system of the retina in lipemia, other than color changes, some writers have recorded their observations with respect to size, tortuousity and general appearance of the vessels.

In one of R. F. Moore's cases, the vessels were markedly distended and tortuous and were about twice their normal diameter. These characteristics were likewise present in the cases of Heyl and White. In Heine's patient, the artieries as well as the veins were much expanded and gave the impression of bands rather than of cylindric blood vessels, and in Hardy's case, the impression gained was that of looking at flat ribbons twice the width of normal veins. In my case there was no suggestion of either flattening or any marked distention. The vessels were about normal in caliber and had not lost their cylindric contour.

It may be of interest to note that in all but three of the fourteen cases, including my own, now on record, the observations were made in the late stages of diabetes, in most instances not long before the fatal termination. In the cases described by H. White, Hardy and the present one, the fundus picture gradually disappeared and the vessels regained their normal appearance. In the patients of White and Hardy, this may have been due to the systematic measures carried out for the relief of the underlying condition. In my case, as has been stated, no op-

portunity was afforded to institute any treatment.

From the very meager reports we have of case histories, it may be assumed that lipemia retinalis is a rare condition. In my opinion the scarcity of recorded cases may be accounted for partly by the fact that these patients, because of unaltered visual acuity, are seldom advised to seek the assistance of ophthalmologists. I believe, too, as has been pointed out by Cohen, that with the more general and systematic use of the electric ophthalmoscope by the internist, a greater proportion of cases will be discovered in the future than there have been recorded in the past.

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STUDIES IN MONOCULAR AND BINOCULAR ACCOMMODATION WITH THEIR CLINICAL APPLICATIONS.

ALEXANDER DUANE, M.D.

NEW YORK.

The results of testing accommodation in 2,000 additional eyes, making in all 4,200, are here recorded, and also those obtained by testing the binocular accommodation in 500 patients. The bearing of these results on the theory of the mechanism of accommodation and their important practical applications are pointed out. Read before the American Ophthalmological Society, May, 1922.

In June, 1912, the author presented to the Ophthalmological Section of the American Medical Association a report[1] summarizing the work he had carried on for five years, on the amplitude of accommodation at all ages. In the chart accompanying the report, the values of the accommodation found in 2,000 eyes were plotted, and from these values a curve was drawn showing the mean and also the maximum and minimum values found for the accommodation at each year of life.

These results showed certain important modifications of the mean curve obtained by Donders in his pioneer investigations made over a half a century before. That the modifications were in general correct is deduced from the fact that the results obtained were derived from eight times as many cases as Donders used, and the tests, moreover, were made under conditions designed to insure rather greater accuracy. For example, Donders assumed that a middle aged individual who had normal vision and did not accept a convex glass was emmetropic. This assumption, we know, is far from correct—such subjects often having a latent hyperopia of a diopter or more. The failure to recognize this hyperopia would obviously make the estimate of the accommodation in the subject tested just that much too low. In our own series of cases, every subject up to the age of 47 was tested under homatropin, in order to determine the true refraction, and on the basis of this finding the results of the accommodative test were evaluated.

A more important difference between the two sets of observations was the fact, that in our series observations

were multiplied, until it was possible to determine with some degree of certainty not simply the mean but also the maximum and minimum values at each age. This was not possible with the comparatively few observations that Donders gathered.

The importance of determining these values, particularly the minimum at

Fig. 1. Accommodation Line. The test for the accommodation consists of a fine vertical line engraved on a card which is held in a suitable clip.

each age, is obvious. In measuring the accommodation in different patients of the same age, we meet with wide variations. Clinically, it is a matter of considerable interest for us to know, first, how wide these variations may be in normal cases; second, what the minimum limit is, below which the accommodation at a given age must be regarded as subnormal. Both these questions are answered by the curves which we have plotted and the tabular values deduced therefrom.

These observations excited but little interest among ophthalmologists. It was felt apparently, as stated by one distinguished critic, that they did not differ essentially from those of Donders, or else, as another man, himself a most able observer, said, that they were mere laboratory experiments and, as such, presumably inapplicable to the conditions of our office work. But both criticisms are invalid. The observations do differ materially and in a very practical sense from those of Donders; and they not only have a very important clinical bearing, but are readily applied in the routine of office work.

Altho in the main these observations have been confirmed by those made continuously since, it has been felt that they needed amplification in two regards. First, the observations at the very beginning and end of the series (below 30 and above 55) were not numerous enough to afford absolutely certain indications as to the maximum and minimum limits. Second, they concerned only monocular accommodation. But, as clinically speaking, binocular accommodation is much more important than monocular, it seemed necessary to determine the former also, and from an equally large number of cases. (See papers 1, 2 and 3.)

Accordingly, the writer has collated the results of five or six thousand observations taken since the original set was compiled, and has added to the latter the values of the monocular accommodation for over two thousand additional eyes. Furthermore, during the last two years, he has made measurements of the binocular accommodation in some five hundred cases, and has determined the relation that this bears to the monocular accommodation in each case. The results are shown in the accompanying charts and tables.

In making the measurements on which these charts and tables are based, the same precautions were taken as in getting the original set[1]. These need not be rehearsed here. I will simply say that in each case the refraction was carefully determined, homatropin being used in all cases of 46 or under, and in some cases above 46; that repeated tests were made whenever possible, the near point being determined by means of the fine

Fig. 2. Accommodation Rule. This is a modified Prince's rule divided into cm. and diopters. The notch at the end is slipped over the nose, so that the zero point of the scale is placed 14 mm. in front of the cornea (practically in the plane of the patient's correcting glass). The accommodation line is carried along either side of the rule to measure the accommodation of either eye separately (the other eye being closed), and along the top of the rule to measure the binocular accommodation (in this case, of course, both eyes being left open). When the line is brought to the point where it just begins to blur or double, the distance of the near point is read off in cm., or the corresponding accommodation is read off in D.

line test object (Fig. 1) and the modified Prince's rule (Fig. 2), either with the full distance correction or with such determinate addition to that correction as would bring the range within measurable limits. In all cases the near point was measured from the anterior focus of the eye (14 mm. in front of the cornea). Every precaution was taken to avoid error and to insure uniformity in methods used. Observations were discarded if repeated observations gave capriciously varying results, or if tests made a year or so later gave higher values.

MONOCULAR ACCOMMODATION.

The values for the accommodation in each eye taken separately, as deduced from the examination of over 4,200 eyes, are shown in Fig. 3, and the maximum, mean, and minimum curves deduced from these values are shown in Fig. 4.

In making these charts, we had to bear in mind that what we are measuring in each case is not the average but the maximum amount of accommodation put forth by each individual. If, for example, a man at various times shows an accommodation of 7.4 D, 7.8 D, and 9 D, and the tests in each case seem equally well authenticated, we say that his range is at least 9 D, the highest of the three measurements, instead of 8.1 D, or their mean. In fact, even the highest accommodation found in a given case may be and often is below the patient's true maximum. Hence a great many of the dots shown in Fig. 3, especially those near the bottom of the mass, should probably be placed a little higher than they are, and hence also the curves drawn in Fig. 4, namely, the minimum curve A skirting the lower margin of the galaxy of dots, the maximum curve C skirting the upper margin, and the mean curve B passing thru the densest portion of the mass, are put as high as they can properly be placed.

The values obtained for each age are given in the following table:

I. TABLE OF ACCOMMODATION AT VARIOUS AGES.

In D and tenths. Near point reckoned from anterior focus of eye (14 mm. in front of cornea).

Age	ACCOMMODATION		
	Minimum	Mean	Max.
8	11.6	13.8	16.1
9	11.4	13.6	15.9
10	11.1	13.4	15.7
11	10.9	13.2	15.5
12	10.7	12.9	15.2
13	10.5	12.7	15
14	10.3	12.5	14.8
15	10.1	12.3	14.5
16	9.8	12	14.3
17	9.6	11.8	14.1
18	9.4	11.6	13.9
19	9.2	11.4	13.6
20	8.9	11.1	13.4
21	8.7	10.9	13.1
22	8.5	10.7	12.9
23	8.3	10.5	12.6
24	8	10.2	12.4
25	7.8	9.9	12.2
26	7.5	9.7	11.9
27	7.2	9.5	11.6
28	7	9.2	11.3
29	6.8	9	11
30	6.5	8.7	10.8
31	6.2	8.4	10.5
32	6	8.1	10.2
33	5.8	7.9	9.8
34	5.5	7.6	9.5
35	5.2	7.3	9.3
36	4.9	7	9
37	4.5	6.7	8.8
38	4.1	6.4	8.5
39	3.7	6.1	8.2
40	3.4	5.8	7.9
41	3	5.4	7.5
42	2.7	5	7.1
43	2.3	4.5	6.7
44	2.1	4	6.3
45	1.9	3.6	5.9
46	1.7	3.1	5.5
47	1.4	2.7	5
48	1.2	2.3	4.5
49	1.1	2.1	4
50	1	1.9	3.2
51	0.9	1.7	2.6
52	0.9	1.6	2.2
53	0.9	1.5	2.1
54	0.8	1.4	2
55	0.8	1.3	1.9
56	0.8	1.3	1.8
57	0.8	1.3	1.8
58	0.7	1.3	1.8
59	0.7	1.2	1.7
60	0.7	1.2	1.7
61	0.6	1.2	1.7
62	0.6	1.2	1.6
63	0.6	1.1	1.6
64 to 72	0.6	1.1 to 1	1.6

BINOCULAR ACCOMMODATION.

The above are the limits for each eye tested separately. For binocular accommodation the values here given for the minimum and mean limits should be increased by 0.6D for ages 10 to 17; 0.5D for ages 18 to 31; 0.4D for ages 32 to 53; and 0.2–0.3D for ages above 53.

This table differs slightly from that determined ten years ago and reprinted since in a number of publications. In particular, the values given, especially at the earlier ages, are somewhat lower. The differences, however, are not material and, in a sense, they are more apparent than real. It must always be remembered that the upper and lower limits determined from a plot of observations of this sort must be more or less indefinite. For the reason already given, this is particularly the case with the lower limit. Thus it is difficult to tell in the case of the lowest dots in Fig. 3 which are to be counted as low normal and which are actually subnormal. Most of them doubtless are to be counted as subnormal, but in order to be on the safe side and to exclude no normal cases, the minimum curve, A, has been set rather low. Thus we are able positively to assert that an accommodation which persistently falls below the minimum value in Table I is certainly subnormal. Quite likely it is subnormal even when somewhat above this limit—at all events, it must be regarded with suspicion.

TABLE II.

Comparison of Monocular and Binocular Accommodation at Different Ages.

Age.	Excess of Binocular over Monocular Accommodation.	
	Extreme excess in D.	Usual excess in D.
8-15	0 to 6	1 to 2
16-34	0 to 3 or 4	0.5 to 1.5 (1D quite common)
35-38	0 to 2.5	0 to 1.5 (usually not over 1)
39-44	0 to 2	Usually not over 1
45-50	0 to 1.4 (in one instance 1.75)	Usually below 1; often below 0.8
51 and higher...	0 to 0.9	Usually below 0.5

NOTE—The extreme differences noted above are in some cases to be regarded with suspicion, it being likely that the subject's observation was faulty or that he failed in the monocular test to put forth his full effort. In one or two instances, however, there is no question that a considerable difference, i. e., one of several D., existed.

BINOCULAR ACCOMMODATION.

In testing the binocular accommodation, the same routine was used and the same precautions were adopted as in testing the monocular. In each case the subject was provided with his full correction, or with a known addition thereto. Then the accommodation was taken with the accommodation line and the Prince's rule, first for the right eye, then for the left, and lastly for both together. At the same time the width of the pupils was measured, both when the eyes were converging to 25 cm. and to 10 cm. This was done in order to ascertain whether there was any truth in the contention that any excess found in binocular over monocular accommodation is attributable not to real increase in accommodative action, but to a sharpening of vision due to the stenopaic action of pupils contracted by the convergence effort. Lastly the distance of the convergence near point was noted, and the presence of any motor anomaly, particularly the presence of any great amount of exophoria in convergence, or any condi-

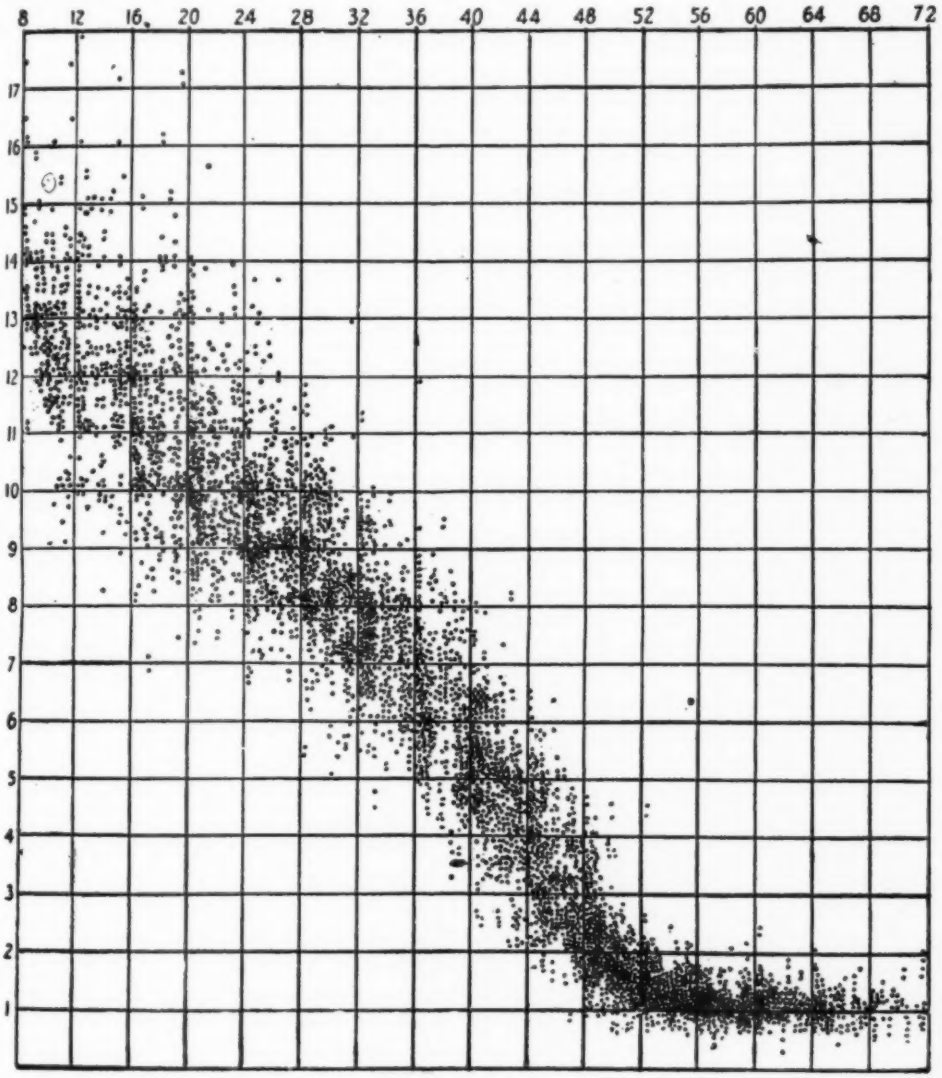

Fig. 3. Values of Monocular Accommodation. Each dot represents the maximum value in D. of the accommodation in a given eye. The results obtained in over 4,200 eyes are here plotted.

tion interfering with binocular fixation or binocular vision at near points.

The values thus obtained for the binocular accommodation, plotted on the same scale as that used for the monocular accommodation, are shown in Fig. 5.

The number of cases examined is yet too few to establish with certainty the mean, maximum, and minimum limits of binocular accommodation, yet the following may be stated as fairly certain conclusions:

1. The binocular accommodation is regularly higher than the monocular. (Compare Fig. 6, in which the monocular accommodation of the cases shown in Fig. 5 are exhibited.) In individual cases the difference may at times be considerable. (See Table II.)

2. The excess, altho varying greatly in different cases and even in the same case at different times, is quite constantly present. There are but few cases in which the binocular accommodation is not notably superior to the monocular; and even when the two seem to be equal, as shown by one measurement, a repetition of the test

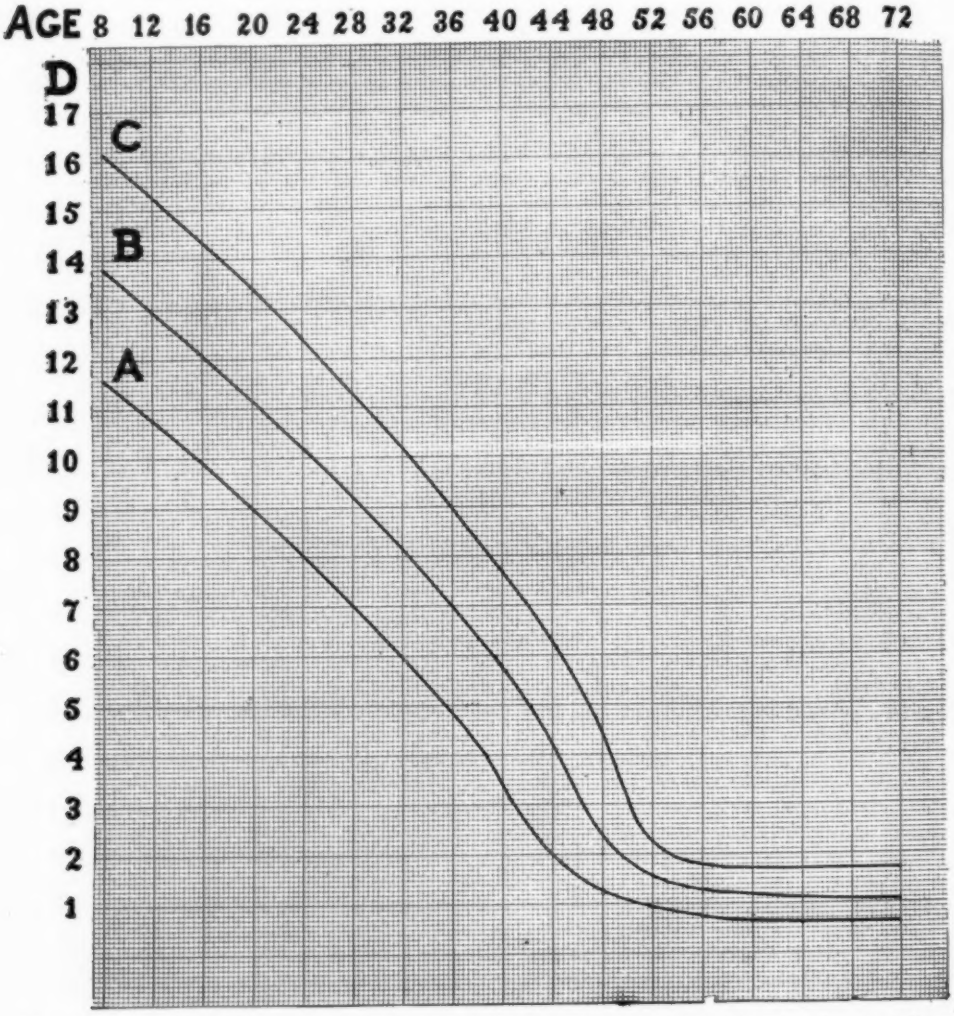

Fig. 4. Accommodation Curves. These are deduced from Fig. 3. A represents the extreme minimum, and C the maximum limits of those dots in the whole mass shown in Fig. 3, which can be regarded as representing normal values. B is the curve representing the mean value of the accommodation.

usually shows that the binocular accommodation is the higher.

3. Only in the rarest instances was the binocular accommodation found lower than the monocular, and even these few cases are open to suspicion, since the values then found were generally deduced from but a single observation, and the conditions were such as not to insure accuracy.

4. While the individual differences between the monocular and the binocular accommodation may run up to 1.5 D or more, the average difference deduced from the entire mass of observations is a comparatively moderate one. Thus the values tentatively derived for the mean value and the minimum limit of the binocular accommodation are, for ages between 10 and 17, about 0.6 D—0.7 D higher than for monocular vision; while from 18 to 31, the difference amounts to 0.5 D; from 32 to 53 to 0.4 D, and for higher ages, to 0.3 D.

5. The excess of the binocular over the monocular accommodation is not in ordinary cases attributable to the clearer vision produced by the contraction of the pupil that the convergence induces. This is abundantly proved by our pupillary measurements, particularly in the older subjects. In these the extra contraction of the

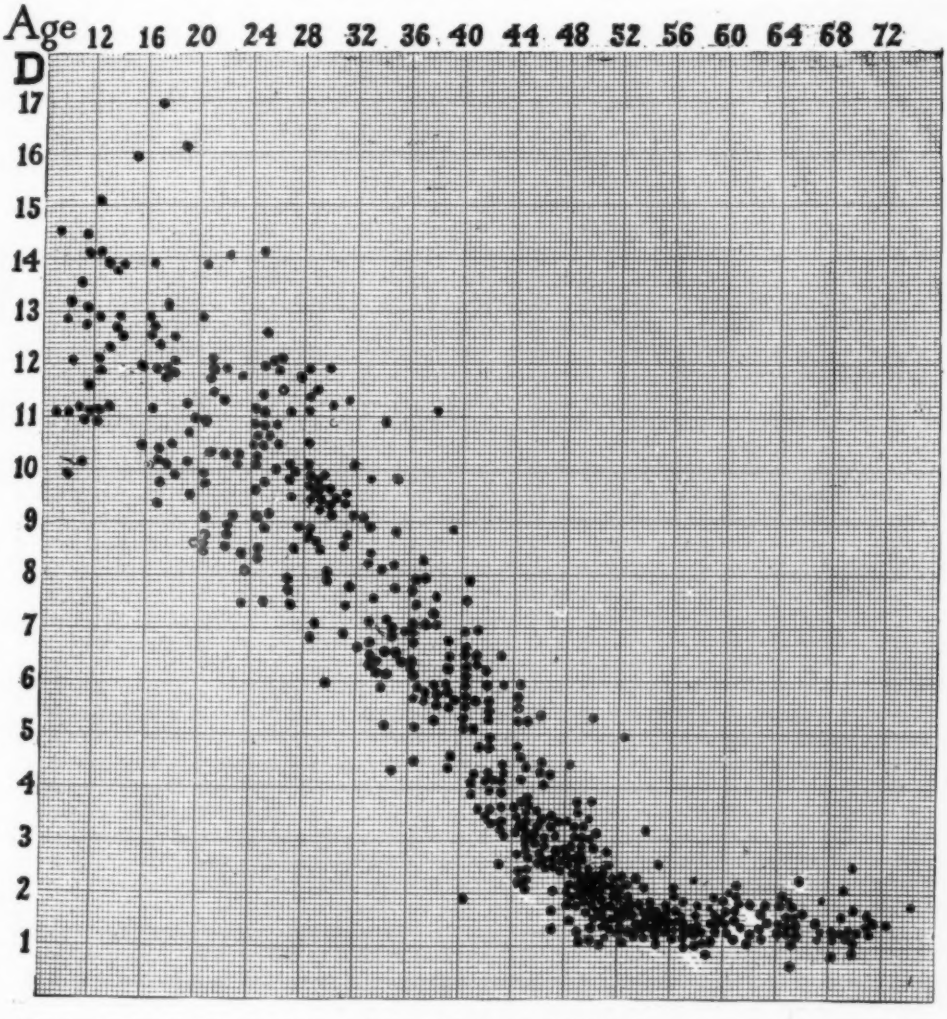

Fig. 5. Values of Binocular Accommodation. These are plotted in the same way as the monocular values in Fig. 3.

pupil set up by converging to the binocular (as distinguished from the monocular) near point, is quite negligible. In very young subjects, with very high accommodation and extremely mobile pupils, this element may be a factor, and may account for the considerable discrepancy sometimes found between the monocular and binocular values.

6. On the other hand, there seems every reason to think that, in the main, the accommodative surplus in binocular vision is due directly to the convergence action itself, which being strongly stimulated sets up an extra accommodative effort, impossible for one who is not converging. In other words, it is a true heightening of the accommodation, not a pseudoaccommodation as would be the case if it were due to the pupillary contraction. The difference, in fact, between monocular and binocular accommodation means that in monocular vision there is a certain degree of inertia of the ac-accommodation, which is overcome by the extra effort set up when the two eyes converge. This inertia must be seated in the ciliary muscle, i. e. is an inertia

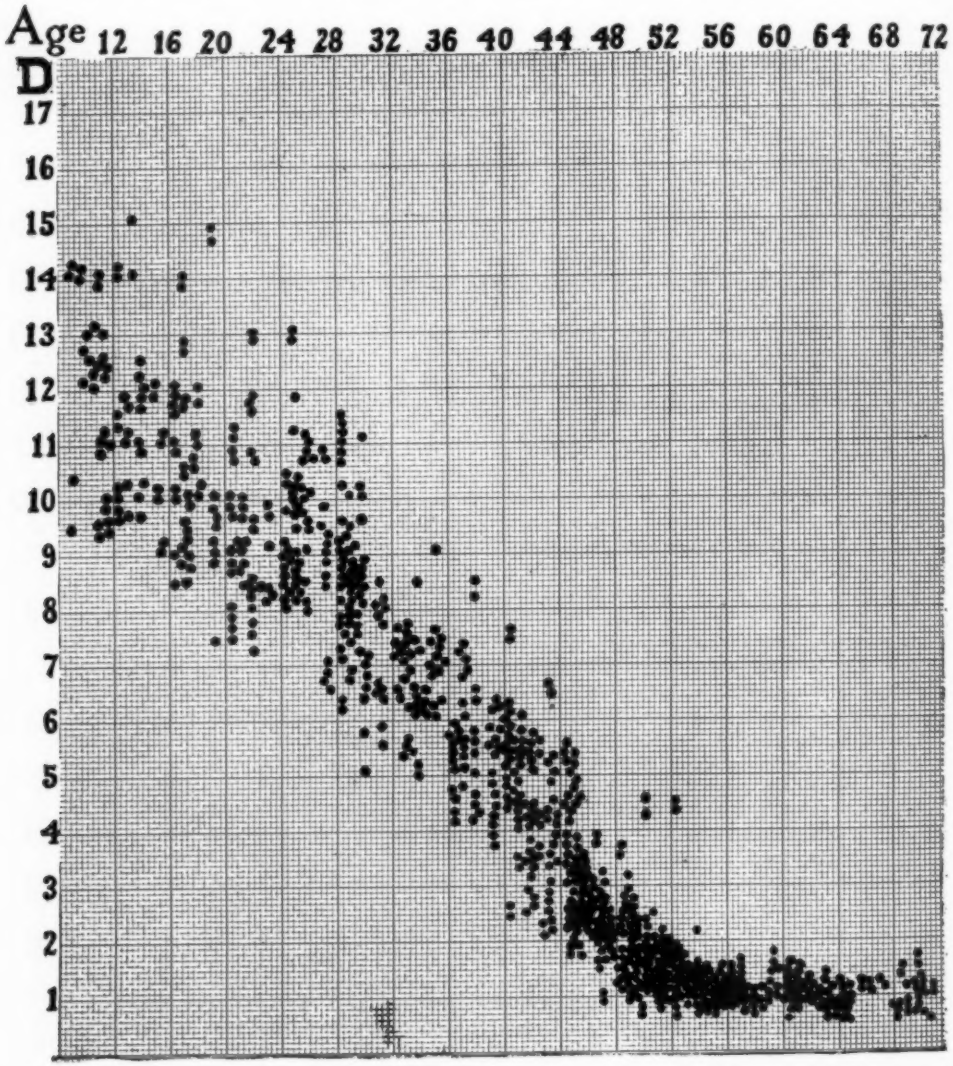

Fig. 6. Comparison of Monocular and Binocular Accommodation. The spots here represent the values of the monocular accommodation in the subjects in whom the binocular values shown in Fig. 5 were determined. It will be observed how the general sweep of the galaxy of dots in 5 rises above that in 6.

of what Fuchs calls the physiologic accommodation.

7. To a certain extent the enhanced accommodation in binocular vision may be due to the added clearness and, we may say, added realness of the binocular as opposed to the monocular image. But this surely is a subsidiary factor. That the enhancement due to the binocular act may be present without it, is proved by the fact, repeatedly observed, that the binocular enhancement exists either when one eye is amblyopic, so that the images cannot reinforce each other, or when there is divergent squint, so that there is no superposition of images at all, and yet still a strong attempt at convergence is made.

8. In any case, the added range and clearness effected by binocular vision constitute a very real advantage, especially in presbyopia. A man who is deprived of the use of one of his eyes is quite aware that his range of near vision is considerably less, and the sight itself is less satisfactory than if he had two. We must reckon with this fact in giving him a reading glass which must, as a rule, be at least 0.5 D stronger than if he were two eyed.

9. Above the age of 55, there is a true accommodation varying from 0.5 D or less to 1.5 D, and averaging about 1 D. The contention is made by some that the accommodation shown at this age is spurious, being due to the small size of the pupil, which so diminishes the size of the diffusion images, that the eye can see distinctly at near points without accommodating at all. This contention is negatived by our observations, which show that often in these elderly subjects the pupils are 3 mm. or more even when converging to their reading point. Nor is the size of the pupil essentially different when the eyes are adjusted for distance and when they are focused for 25 cm., which is about the nearest point to which they are usually adjusted by glasses. We may say, then, that ordinarily distinctness of near vision is not secured in these older subjects by a contraction of the pupil.

In very young subjects, as we have already seen, a contraction of the pupil may possibly produce a pseudoaccommodation, but our observations lead us to suppose that this occurs but rarely.

THEORY OF THE MECHANISM OF ACCOMMODATION.

Accommodation is effected by a passive expansion of the elastic lens, that takes place when the pressure exerted by the suspensory ligament upon the lens is relaxed. This passive expansion is aptly termed by Fuchs the physical accommodation, and the near point to which the eye can be actually focused by the elastic expansion of the lens is called the physical near point. Owing to the sclerosis which takes place in the lens progressively from youth on, the physical accommodation steadily diminishes and the physical near point steadily recedes with age.

Contrasted with this purely passive expansion, which decreases from year to year, is the active contraction of the ciliary muscle by which the relaxation of the zonula and hence the passive expansion itself are effected. This active contraction constitutes the physiologic accommodation (Fuchs), and the near point to which the eye could be adjusted if this active contraction were pushed to its limit and the lens also were perfectly fluid, is the physiologic near point.

Now while the physical accommodation diminishes steadily from youth up, it is generally held that the physiologic accommodation does not diminish at all until advanced life. There seems, indeed, no reason why the ciliary muscle, which is kept in continual practice all thru life, should contract any less vigorously at the age of 45 than it does at the age of 10. In fact, persons of both ages should have a physiologic accommodation of maximum amount, equivalent to a physical accommodation of not less than 20 D.

Now this inference, which is fully accepted by Hess and other exponents of the Helmholtz theory, involves certain corollaries which are not borne out by clinical evidence.

For example, suppose that a man of 45 has a maximum physical accommodation of 4 D, i. e., this represents all that he can possibly do in the way of relaxing his lens. This relaxation involves a very moderate amount of ef-

fort on the part of the ciliary muscle—in fact only a fifth of the whole 20 D that the full activity of the latter is supposed to represent. It would seem perfectly easy for him to put forth this minimum amount of his total ciliary activity and under all conditions get 4 D of manifest accommodation. Now, as a matter of fact, this is not the case. Tested with either eye singly, such a person rarely exerts more than 3.5 D. and often not over 3 D of accommodation. When in this case he shows only 3 D of physical accommodation, it is evident that this also represents the total ciliary effort (physical accommodation) that he is making at the time; for if he made any greater effort his physical accommodation would rise above 3 D, since the lens itself can relax up to 4 D if the ciliary muscle contracts correspondingly. Instead, then, of uniformly showing 4 D of accommodation under all conditions, he does so only under the extra stimulus afforded by binocular vision and convergence, and even then attains the maximum only part of the time.

The above statement holds good even up to the age (60 or over) when the accommodation is reduced to a minimum. Thus a person of 60 who has a monocular accommodation of only 1 D, will quite regularly have a binocular accommodation of 1.3 to 1.4 D. The extra amount of ciliary contraction required according to the ordinary theory, to produce the sight additional relaxation which would be neeeded to effect the differences between 1 D and 1.3 D of lenticular refraction is so small, that one does not see how anybody could fail to make it if he had a really large ciliary power to draw on. Yet evidently nearly everyone does fail to make it, unless some extra stimulus like that imposed by binocular vision and the convergence of the eyes impels them to a maximum effort.

It seems inconceivable that one who really had a contractile force equivalent to 15 to 20 D should be unable to put forth under all conditions, when called on, the comparatively small fraction required to produce a change of 2 to 4 D in the refractive state. Far more likely does it seem that from some cause—perhaps from physiologic inhibition — the ciliary energy itself actually diminishes with the years, i. e., that the physical and the physiologic accommodation diminish together, altho not necessarily at the same rate.

What lends additional plausibility to this view is the behavior of the eyes under homatropin. According to the usual views as enunciated by Hess and others, a boy of 15, a young man of 25, and a man of 40 would each have a physiologic accommodation (ciliary contraction) of equal amount, say one equivalent to a physical accommodation of 20 D. The actual physical accommodation, produced by the relaxation of the lens, would on the contrary be very different. In the first case it might be 16 D, in the second 10 D, in the third 5 D. In the first case there would thus be 4 D, in the second 10 D, in the third 15 D of latent ciliary energy, i. e., of energy which is never expended in changing the shape of the lens, and the abolition of which, therefore, would produce no effect on the physical accommodation. If now we instill a gradually acting poison like homatropin into the eyes of all these subjects, it should begin to show an effect only after the latent energy in each case had been abolished by the paralysis. In the case of the boy, as only 4 D are latent, the effect should be manifest very soon—in about ten minutes—after the instillation. In the second case the effect should not be manifest until quite a little later, and in the third case it should be manifest only after the lapse of 30 or 40 minutes, if at all. Now as a matter of fact, in a great many instances at least, the cycloplegia begins to show itself almost if not quite as soon in the middle aged man as it does in the boy. In fact, in persons of 46 or 48, the cycloplegia due to homatropin may become manifest in from 10 to 15 minutes after the instillation, and then proceed at a rate quite like that of the youth. These facts are supported by a large number of observations in which care was taken to exclude disturbing factors, such as the blurring due to the mydriasis, etc. It does seem, therefore, that the hypothesis that the ciliary power in the young and middle aged is equal is untenable.

THE ACCOMMODATION IN MALES AND FEMALES.

Examination of the great mass of statistics shows that, in general, the accommodation is equal in the two sexes, and that the march of presbyopia is the same in each. This is graphically shown in Fig. 5.

POSTCYCLOPLEGIC EFFECTS OF HOMATROPIN.

Ordinarily the effect of homatropin, if applied in a thorogoing way, may be said to wear off in 48 hours. But a moderate effect noticeable by careful tests often persists for several days later. For this reason it is best to defer a postcycloplegic test till five or six days, at least, after the instillation.

There is, however, a more lasting effect produced by the instillation, especially in eyes with latent hyperopia. We have repeatedly noted that tests made even some weeks after the homatropin, and after the application of the correcting glasses, show an accommodation distinctly below that present before the use of cycloplegic. It would seem as if the eye, having once learned to give up a compensating accommodative effort, could not for a time thereafter put forth even the normal accommodative power. Whether this postcycloplegic accommodative insufficiency, which usually is never of any great amount, produces any symptoms or not I do not know.

CLINICAL APPLICATIONS.

The observations recorded have an important clinical bearing[2,3]. Since they establish the norms of accommodation, they afford a means of judging when and how such a given accommodation varies from the normal.

Subnormal Accommodation; Hypocyclosis.—Since the days of Donders, the rôle of accommodative strain in causing the asthenopia of hyperopes and astigmatics has been a commonplace. It is all the more remarkable that, on the whole, so little attention has been paid to the part played by subnormal accommodation in causing eye troubles. Rarely, in fact, is the accommodation tested except in a perfunctory way, and, previous to this series of investigations, there has been little if any attempt to fix the maximum and minimum limits of accommodation at each age. Yet until these latter are known, we cannot, except in extreme instances, say definitely whether a given accommodation is normal or not.

It can now be positively stated that a monocular accommodation which is persistently below the minimum limit indicated in Table 1 is certainly subnormal, and that it is probably subnormal if it never rises much above this limit. Furthermore, the binocular accommodation should in young persons be at least 0.5—0.6 D, and in older subjects 0.3—0.4 D higher than this minimum.

It does not fall within the scope of this paper to consider at length the varieties, symptoms, and treatment of subnormal accommodation. It will suffice to say, that it is a frequent condition and that there are two kinds. In one, which may be called lenticular hypocyclosis, the ciliary muscle apparently acts in normal fashion, but the crystalline lens is more rigid than usual. In other words, there is a condition of premature presbyopia. In such a case, there are few if any symptoms of eyestrain, but as years go on the accommodation remains persistently lower than normal, and presbyopia sets in much earlier than usual.

In the second kind of subnormal accommodation, the lens has the usual rigidity, but the ciliary muscle is underactive. Except in cases due to structural disease of the central nervous system, the accommodation in this variety shows wide variations from time to time, and when it is low there is often marked asthenopia. This form of low accommodation is often associated with convergence insufficiency, and the symptoms often attributed to the motor anomaly are without doubt in many cases due to accommodative disturbance, or at least are aggravated by it.

Ciliary hypocyclosis can often be relieved and the symptoms greatly helped by convergence training and by direct training of the accommodation. For the latter purpose, exercise several times a day in focusing on the accommodation line, first with one eye, then with the other, and lastly with both, is useful.

Unequal Accommodation; Anisocyclosis.—Not infrequently the accommodation is found to be unequal in the two eyes. Usually this inequality seems to be due to unequal rigidity of the crystalline lenses. It rarely causes any disturbance, but has to be reckoned with in correcting presbyopes; for if they show an unequal accommodation, it is sometimes helpful to give them also an unequal addition to the correction for distance. The fact that the accommodation may be thus unequal in the two eyes is sufficient reason for our habitually testing it in each eye separately as well as in both together.

Accommodation Measurements in Testing the Depth of Homatropin Cycloplegia.—This is an application of the accommodation tests which I regard as of great importance. The ordinary practice of making the refractive examination at a fixed time—an hour, it may be—after the first instillation of the homatropin, leaves out of consideration the fact that the march of homatropin cycloplegia varies greatly in different persons. In some few it seems complete in less than an hour; in others it is not complete for some two hours. Moreover, there seems reason to think that the acme of the effect is soon passed; at least if the test is not done until long after the instillation, the results may be uncertain.

The most satisfactory method is to make tests of the residual range at intervals, beginning an hour after the first instillation, and to defer the examination of the refraction until the range has been reduced below 1 D, then make it at once. Furthermore, when the refraction has been determined, the far point with a +3 D. added to the full correction should be at 33 cm. and the near point at something over 25 cm. and preferably not less than 28 cm. (representing in the latter case a range of 0.6 D). When the range is much wider than this, our results must be regarded as somewhat uncertain.

ACCOMMODATION TESTS IN OFFICE PRACTICE

The tests used require only the simplest of apparatus and can be made very quickly. They are hence adapted to the exigencies of office practice, of which, considering their importance, they should form a part in the regular routine of the examination of each case. In applying them the following precautions should be used:

1. The patient is placed in a good light and provided with his full correction, and (in presbyopic cases) with such addition thereto as will bring his near point within measurable limits. In this case, of course, the accommodation read off on the scale must be diminished by the strength of this added glass.

2. In very young subjects with high accommodation (12 D or more), it is often well to add a —3 or —4 D to the distance correction, in order to carry the near point out to a place on the rule where, the graduations being further apart, there will be less likelihood of error in the measurement. Of course, in this case the accommodation as read off on the scale must be increased by the strength of this added glass.

3. The zero point of the Prince's rule is placed 14 mm. in front of the cornea (practically in the plane of the patient's correcting glass).

4. The left eye is covered and the accommodation card carried in along the rule until the line seen with the right eye blurs or doubles. The corresponding value of the accommodation is then read off in D. Then the right eye is covered, and a similar test made with the left, and lastly the accommodation is measured with both eyes open, the patient at the same time being urged to converge on the test-object.

5. It is well to make sure that the patient understands exactly what we desire him to observe, and to make several observations in succession in order that we may get his maximum effort.

SUMMARY.

1. The examination of the accommodation in 4,200 eyes enables us to state with precision the maximum and minimum limits, as well as the mean values of the monocular accommodation at all ages. The results obtained are shown in the curves and tabular values here presented.

2. These observations substantially confirm those made ten years ago. The mean and lower limits have been set somewhat lower, so as to be sure not to exclude any low normal cases. Any case whose accommodation is persistently below the minimum limit is certainly subnormal, and any case in which the accommodation remains only slightly above the minimum limit is probably so.

3. The binocular accommodation is regularly higher than the monocular, the excess being regularly equal to 0.6 D or more below the age of 17; 0.5 D from 18 to 31; 0.4 D from 32 to 53; and 0.3 D for ages over 53. In individual cases the difference may be much greater.

This difference is a very real advantage especially in presbyopes. Binocular accommodation is not only higher but better as regards ease and clearness. This fact must be borne in mind especially in prescribing reading glasses, and in cases of monocular vision (monocular cataract, etc.), we must prescribe a glass 0.5 D or so stronger than we would for a two eyed patient.

5. The excess of binocular accommodation apparently represents an actual increase of ciliary effort, imposed doubtless by the act of convergence. It cannot be attributed to the added clearness secured by a contraction of the pupils, since it is quite uniformly observed even when no such contraction exists.

6. As little can the contraction of the pupil be called in to account for the accommodation of 1 D or more, quite regularly observed in patients over 55. The accommodation in this case, in all probability, represents the same process as in youth, i. e., relaxation of the lens produced by contraction of the ciliary muscle.

7. These observations and others adduced should lead us to modify somewhat our conceptions of the accommodative process. Particularly these should lead us to think, contrary to the prevalent view, that not only the elasticity of the lens (physical accommodation) but the activity of the ciliary muscle (physiologic accommodation) diminishes with age, and that in advanced life only a comparatively small amount of ciliary energy can be put into play.

8. The accommodation is equal, and presbyopia advances at the same rate in the two sexes.

9. The relaxation of effort produced by homatropin and by the prescription of correcting glasses seems in many cases to set up a condition of moderate accommodative insufficiency, lasting, it may be, for a number of weeks.

10. The practical applications of these observations are of considerable importance. In particular, the observations determine whether a given accommodation is subnormal or suspiciously low, and enable us to tell when we have succeeded in raising it to near the normal limit. Subnormal accommodation is frequent and comprises two kinds, lenticular and ciliary. The former, which may be called a premature presbyopia, is a stable condition, causing apparently little or no reflex symptoms; the latter is a variable condition, often causing marked asthenopia and requiring active treatment. The other practical applications consist, first, in the recognition of the fact that the accommodation may be unequal in the two eyes, so that in presbyopia an unequal reading addition may be required; and, second, in the employment of the accommodation tests in determining the depth and reliability of homatropin cycloplegia.

11. In order to make the tests available for practical application, they should be performed in a uniform way and with certain precautions. When so performed they give reliable results. They are readily and briefly made with simple apparatus, and hence are easily adapted to the conditions of ordinary office work.

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A FEW OF THE MANY RESULTS OF A SLOW, PAINLESS CYCLITIS.

G. HERBERT BURNHAM, M.D., F.R.C.S., EDINB.

TORONTO, CANADA.

A case is reported in which slow, painless cyclitis preceded cataract operation. In the second eye, the lens on removal resembled a cyst with a thick leathery capsule. In a second case, iridocyclitis developed six days after cataract extraction. Preliminary iridectomy is advised for such cases.

A woman, Mrs. G., now aged 75 years, consulted me several years ago with respect to a dimness of sight of the left eye. I found on examination a cloudiness of the nucleus of the lens —a good a.c., p. a little larger than usual in elderly people, which tho active, did not contract fully. O. D. normal—T. full.

Viewing this condition, as the outcome of the presence of a slow, painless cyclitis, I did an iridectomy. R. eye had good vision, and was apparently unaffected, tho the pupil had a suspicious look.

The ciliary processes in cases of senile cataract are seldom normal, and very often indeed vary from the healthy standard much more than is suspected: for unfortunately there are not, at present, any means of estimating their exact state, and hence the ever dreaded cycloiritic complications following cataract extraction. The left lens got more opaque, and at the end of three years was mature. At this time the right eye began to show the same condition as the left, when it was first seen by me. I now performed an iridectomy. A few days later, I did a cataract extraction on the left eye. When I introduced the pricker and had gently touched the lens, it was dislocated downwards. I now used the wire scoop and removed the lens in its capsule, without loss of vitreous. This was a hard opaque lens with a firm capsule.

If the extraction of a cataract similar to this, using a scoop, be accomplished without loss of vitreous, this latter is often due to the effects of a slow, painless cyclitis and not to any unusual skill of the operator. Tho the eye healed kindly with media clear, R. normal Tn., still the vision was only 6/9. I think that the vitreous remained intact owing to the change in its structure, that is, becoming firmer due to the cyclitis. Hence it bore the pressure of the scoop without giving away, and also accounts for the imperfect vision. The lens, being also weakened in its attachments from the same cause, became loosened on very slight pressure.

The lens of the right eye, becoming gradually more opaque, was in two years mature. A little later I operated and had a different experience, but one which more pointedly showed the presence of cyclitis as a cause. When I introduced the pricker, there was a very slight dislocation of the lens, and being on the alert, I at once withdrew the instrument. The dislocation being very slight, I applied pressure with the spatula and quite easily delivered the lens in its capsule without loss of vitreous. The lens, however, instead of coming out with the usual rigid shape, was merely an elongated mass. On examination, I found that it resembled a large cyst, the capsule being thick and leathery, and the contents fluid, and floating in the center was a small dark colored nucleus.

The eye did well. These cases, one may say, so uniformly do well, the nonpresence of soft lens substance and lacerated capsule being the great factors. Thus there are completely removed the two most fruitful sources of irritation of the ciliary region. However, when these two sources are not removed, then we can and do have,—thru their irritation of the ciliary processes, which latter in these cases are always unhealthy in varying degrees, and thus easily aroused—all varieties of inflammation from the slightest iritic adhesion or a slight thickening of the capsule to a cycloiritis, even purulent in character.

This is to me the explanation of the socalled endogenous infection. Very seldom indeed, is there that complete absence of all signs of inflammation, noticed when the lens is removed in its capsule. In the complete removal of lens and capsule lies the chief claim that Colonel Smith's operation has to the superiority, which it does possess in regard to the other operations, practiced for the removal of the mature senile cataract.

Of the left eye, after the operation, V. with glasses was 6/9. Two years later the vision was 6/12, media being clear and Tn. The right eye one year after the extraction, V. = 6/9, media clear, Tn. The condition of the right lens could assuredly be ascribed to the cyclitis.

When in the usual cataract extraction, a lens comes away easily, and everything goes smoothly and the parts are well in situ, it is known to us all that the eye sometimes does not heal kindly, owing to a slow, almost painless cycloiritis, the socalled glaucomatous condition being one of the sequels. The unhealthy ciliary region causes a weakness of the structures, and hence the lens readily glides out of the lacerated capsule on pressure, and the eye also readily succumbs to an inflammation.

When the scoop is used in a case of dislocation of the lens and vitreous is lost, it is that the structures supporting the vitreous chamber are weakened from the painless cyclitis and easily give away on pressure. If the vitreous be healthy, a good result will follow: but if fluid, then a slow cycloiritis sets in and the eye is sooner or later practically lost.

The fluid vitreous shows that the cyclitis has also implicated the vitreous chamber. Of course, under ordinary circumstances, when healthly vitreous is lost, it is very much more often due to a sudden squeezing of the eyelids of the patient, or the want of deftness on the part of the operator than to a cyclitis. When, however, the vitreous is fluid, then the loss is much less frequently due to the patient or the operator, than to the cyclitis. Thus it is, that in one case the cyclitis causes an increased firmness of the vitreous and in another a fluidity. In the lens, apparently, there may be the same diversity of effect, but in the same patient, in that the lens of one eye is in a decidedly hard, and the other a decidedly fluid state. In this right eye, however, the changes produced strikingly exemplify the very marked degenerative condition, that the slow, painless cyclitis is capable of producing.

I have not yet resorted to any continuous internal medical treatment on account of certain attending difficulties: but if any further deterioration of the vision of either eye takes place, I shall promptly enforce its use.

My second case, a man, Mr. J——, aged 78 years, had his mature senile cataract removed by me. I performed the usual cataract extraction quite satisfactorily. At the end of the fifth day, the eye was doing well, the pupil being dilated and only a little lens substance and lacerated capsule in the pupillary area. On the sixth day, suddenly and unexpectedly, severe iridocyclitis was developed. Seeing that the eye would be lost unless energetic means were used, I resorted to the use of the "Combined Treatment" with speedy relief and finally a good result. This case was thus one of those with unhealthy ciliary processes, where there had been no previous suspicion of such a condition. If I had been able to diagnose the true state of these processes, and had practiced the same treatment prior to the operation that I did afterwards, in all likelihood the attack would not have occurred.

Again, in the second case had I performed Smith's operation, instead of the one I did, and thereby have completely removed the two sources of irritation, namely soft lens substance and lacerated capsule, I feel that I would have had a good result without any inflammatory complications.

And vice versa in the first case, if I had not completely freed the eye of lens substance and capsule, I would undoubtedly have had severe iridocyclitis.

These two cases, it seems to me, emphatically impress upon the mind of

an oculist two things: one that Smith's operation, or one that completely removes lens and capsule, is preferable to the operation that does not: and the other that it is necessary sharply to scrutinize the eye before operating as to the condition of the ciliary processes, and to be able to estimate their departure from the normal standard. If this be done, then if confident that disease is present, there are two ways to act,—one to do Smith's or a similar operation—and the other, if the usual operation be preferred, to prepare the eye by previous treatment with Hyd. and iodid, or still more effectually by the use of the "Combined Treatment."

These conclusions seem to me to be rational and to enable reliable preventative measures to be used. It is especially so, when nonsuccess has already occurred in one eye, and the operator does not wish to practice Smith's or a similar operation, but again to perform the same one in the remaining eye.

An additional preventative measure would be to do a preliminary iridectomy, tho it is so scathingly denounced by some oculists, but I beg to say, unjustifiably: for those cases in which a preliminary iridectomy has been followed by an inflammation, have been so affected on account of the inherently diseased condition of the ciliary processes, and not on account of any increased liability arising out of the preliminary operation, as this latter has a contrary, deterrent effect.

THE IMPORTANCE OF HETEROPHORIA TESTS IN ROUTINE REFRACTION.

H. H. Briggs, M.D.

ASHEVILLE, N. C.

The mutual relations of heterophoria with errors of accommodation are discussed. A distinction is made between accommodative convergence and fusional convergence. The significance of various forms and manifestations of heterophoria are considered. Presented in the Section on Ophthalmology of the American Medical Association, at the St. Louis Meeting, May, 1922.

Homer failed to state why "Odysseus bored out the eye of Polyphemus," but we can safely infer that it was not a surgical measure for the relief of asthenopia, for with but one eye the Cyclops must have been free from the exacting demands of coordination necessary to binocular single vision. Rather, he was fortunate in the possession of a monocular system requiring only an incoordinated fixation and accommodation, and incidentally the ordeal of a single instead of a double operation. It is only in man in the highest, and in a few of the anthropoids in a lesser degree, that the most extraordinary function of binocular single vision has, in the process of evolution, been attained. It is, moreover, chronologically considered, one of the more recently acquired coordinating functions and, therefore, less stable than, more easily influenced by, and subservient to, the older fundamental functions. Heterophoria is, therefore, essentially a problem of evolution in physiology. Among the lower vertebrates, in the hare, for example, the orbits are on opposite sides of the head, and the visual axes directed so nearly opposite that the two visual fields probably nowhere overlap. Further up, in the dog, much of the two fields is in common, and fair binocular vision is probable. Yet there is no evidence of a perfected binocular vision. In monkeys, the visual axes may approach parallelism and some may have acquired slight convergence, and most probably a moderate degree of binocular single vision. In man, it is a function of such mechanical precision as is nowhere else exhibited in our physiology, and subject to an error of less than a fourth of a minute of an arc.

The subject of heterophoria is most difficult because the function of muscle balance involves the coordinating action of two or more of the twelve extrinsic muscles, acting as a duet, quar-

tet or sextet, in association with the function of the intrinsic muscles, and under a myriad of circumstances involving varying distance and direction; yet, to meet the demands of binocular single vision, this balance must be of sufficient accuracy to satisfy the requirements of a mathematically exact horopter. Furthermore, no two cases of heterophoria are exactly alike, each having its own peculiar individuality, ever changing with the nervous status of the patient.

It is unfortunate that heterophoria has received such a small share of the study it deserves, and that its teachings are so little used in the practice of ophthalmology. I am convinced that there are many students well grounded in the principles of ophthalmology, having a good working knowledge of muscle balance, who, except in very apparent cases of asthenopia of muscular origin, seldom utilize the tests for heterophoria. Some ignore heterophoria as the cause of asthenopic symptoms, while the opposite extremists attribute many of man's ills to a few degrees of imbalance. Fortunately, however, the subject of heterophoria has had the earnest consideration of many of our most untiring scientific investigators, who have left us the golden fruits of their labors.

The excuse for occupying the reader's time with this much discussed subject is the fact that from one-quarter to one-third of all cases of asthenopia are due to anomalies of muscle balance, which cannot be cured by the correction of refractive errors alone. Reber[1] says: "A review of 1,000 refractive and muscular cases in the writer's private practice indicates that about 70 per cent of them were relieved of their symptoms by the use of their correction alone. The remaining 30 per cent required some manner of attention to their oculomuscular status to bring about more or less complete relief."

What are we doing for this unfortunate class of patients? It is for the purpose of calling attention to this very important subject in every day practice of ophthalmology, especially in refraction, and in the consideration of the causes of asthenopia, and with the hope that some of the phases of the subject may be elucidated, rather than to present any new findings, that this paper is presented.

In order to be able to recognize anomalies in muscle balance, we should familiarize ourselves with the normal functions of convergence and accommodation and their relations to each other, and to achieve this knowledge, the student should adopt rules for observing the necessary data; for it is only by careful observation of the normal that we are able to detect the abnormal, and it is especially necessary to form the habit of methodically recording the data thus found, for the sake of thoroness, for your own information, for the patient's sake and for the advancement of scientific knowledge.

I venture, therefore, to enumerate below certain data to be sought during the routine examination for refraction. Certain essential tests should be made in every case, and most, if not all, should be utilized in asthenopic cases, especially those in which the patients have not definitely improved after wearing the refractive correction. Except when it is otherwise stated, the tests should be made with the proper ametropic correction worn.

ACCOMMODATION.

The determination of the accommodative power of each eye should be a routine in refraction, regardless of the patient's age. Many of our failures in refraction work have been due in part to a lack of this important datum. The punctum proximum (P.P.) is the nearest point at which, with maximum effort of the ciliary muscle, distinct vision is possible. A suitable test object, amply illuminated, and corresponding in size to that of Jaeger 0.5 diopter or larger, if necessary, depending on the visual acuity, and a 50 centimeter rule are ample equipment. The fine short line 1/3 by 3 mm. in India ink on white cardboard, as devised by Duane, is especially adapted. I myself have found different sizes of black horsehair stretched across white cardboard quite as satisfactory. The test object is ad-

vanced toward the eye, the other eye being covered, until the image begins to blur. This locates the punctum proximum and its distance from the anterior focus of the eye (from 13 mm. in front of the cornea) or from the plane of the trial frame is the linear measure of the maximum accommodation of the eye. Since 100 cm. is the unit focal length, 100 divided by this distance (100/P.P.) equals the diopters of accommodation represented. Each eye should be thus tested and the results recorded as part of the necessary data in the consideration of the relation of accommodation to convergence. If mathematic accuracy is desired, the measurement should be made from the nodal point rather than from the anterior focus, but the latter is more convenient. The punctum remotum (P.R.) is the point at which the eye is focused when in a state of complete repose. In emmetropia, it is at infinity; in myopia, within infinity or at a finite distance; and in hyperopia, it is beyond infinity or virtual and its distance negative. Since the refractive power (R.) is the inverse of the focal distance (P.R.) measured in meters, R. = 1/P.R., giving in diopters the plus value of P.R. in myopia and the negative value in hyperopia. These two distances (P.P. and P.R.) may be expressed in diopters, and their difference represents the amplitude of accommodation. Donders, Duane, Jackson and others have recorded abundant data on normal accommodation at various ages, the graphic curves of which are familiar to all. Duane's[2] show a gradual retrogression of the punctum proximum from the age of 8 or 10 to that of 51, after which the retrogression is very slow, changing only 0.5 diopter in ten years.

Among anomalies of accommodation may be mentioned[3] insufficiency of accommodation, the punctum proximum being constantly farther away than normal for the particular age; excessive accommodation; inequality of accommodation of the two eyes, and a sluggish or ill sustained accommodation. As causes may be mentioned toxemia, nasal reflexes, vascular hypertension, neurasthenia, and excessive use of eyes and undue and unequal rigidity of the lens.

RELATIVE ACCOMMODATION.

Relative accommodation is the amplitude of accommodation for a given amount of convergence. The greatest amount of accommodation for a given convergence is measured with the strongest minus sphere with which the object can be seen distinctly, and is known as the positive relative range of accommodation. The negative range of relative accommodation is measured by the strongest plus sphere possible without blurring the image. At 6 meters, the emmetropic eye free from presbyopia will accept a minus 3 D. sphere or more and maintain distinct vision; but for obvious reasons will not accept any plus sphere. Consequently, for distance there is about 3 diopters of positive and no negative relative range of accommodation. Similarly, at one-third meter, the positive and negative ranges are found; but from the positive must be deducted and to the negative added plus 3 diopters, which represents the normal convergence at one-third meter. In ametropia, a disturbed relationship exists between accommodation and convergence, which relationship rather than the ametropia per se is the principal cause of asthenopia. In hyperopia and hyperopic astigmatism, there is anatomically excessive negative and reduced positive relative accommodation, and in myopia and myopic astigmatism the reverse is true—an excess positive and a less negative relative accommodation. A person with hyperopia of 3 diopters may have 3 or more diopters of positive and 3 of negative relative accommodation for distance and a similar disproportion for near. A person with myopia of 3 diopters has no negative relative accommodation for either 6 meters or one-third meter, and a proportionately large positive range of accommodation.

TONICITY.

The natural anatomic position of a pair of eyes during sleep, drunkenness, anesthesia or death is that of diverg-

ence, and according to LeConte[4] and Prentice ranges up to 20 degrees or more. This tendency to divergence is overcome by innervation (Prentice) or tonic convergence (Maddox). There is diversity of opinion as to the importance of the tonicity test, owing in part, no doubt, to the various methods employed by different observers. This test is made in a darkened room at 6 meters, first without and afterward with the patient's correction. It is generally conceded that, in order to obviate the tendency to fusion, the false image should be such and in such position that it will fall outside the fusion area, which, according to Savage,[5] extends vertically 3 degrees upward and downward, 8 degrees nasalward, and 25 degrees temporally. The displaced images with the double prisms, bases horizontal, show a greater amount of divergence of the visual axes (more exophoria or less esophoria) at 6 meters than does the distorted image of the Maddox rod, whose image extending across the fusion area stimulates fusion convergence. In order that the vertical and oblique muscles may be as nearly at rest as possible, the light or test object should rest on the extended horizontal plane. Each eye should be tested separately, the image of the other eye being undisturbed. Under these conditions, an exophoria of from 0 to 1 degree, in my opinion, is within the normal. This "physiologic exophoria" is less if the test object, a star, for instance, at infinity, is used instead of the light at 6 meters, where there may be, in the latter case, as much as 0.16 diopter of associated accommodation inducing slight convergence. The nearer the test object is approached, the greater the amount of this exophoria which fusion convergence compensates for under ordinary demands of binocular single vision.

The vertical tests for the vertical muscles should show the images in perfect alignment when the double prisms are turned bases vertically. In order to obviate the tendency to fusion of the lights in these positions, a prism *base in*, sufficient in strength to place the image of the eye examined beyond the fusion area, may be in some cases better suited for the vertical muscle test than is the double prism.

The tonicity test at 6 meters taken alone is of little value except when correlated with that of duction, convergence and accommodation, and especially with the refractive error.

COVER TEST.

This test, while not accurate in amount, is most responsive, the most convenient, and the quickest test for heterophoria of considerable degree, and is both an objective and a subjective test. The covered eye wanders in the direction and to the position of rest, and when uncovered, the redress toward the point of fixation is easily noted by the observer, and the seemingly reverse motion of the object by the patient. This test is especially serviceable in roughly determining the existence of conjugate muscle imbalance, especially convergence insufficiency and excess for near.

CONVERGENCE.

Convergence is the angular relationship of the visual axes. The distance of the intersection of the visual axes from the base line connecting the centers of rotation divided in to a hundred, measures in meter angles the amount of convergence of each eye, and this multiplied by 7 measures approximately in degrees the amount of convergence. To be more accurate, one-half the interpupillary distance divided by the distance of the object equals the sine of the angle.

The punctum proximum of convergence is the point of intersection of the visual axes during maximum convergence. Duane finds this to be normally about 7.5 cm. from the base line connecting the centers of rotation, representing about 13.3 meter angles of convergence. The punctum remotum of convergence is the intersection of the visual axes when at the least convergence (or greatest divergence). The difference between the maximum and minimum convergence represents the amplitude of convergence and is measured in meter angles, prism diopters, or degrees.

ACCOMMODATIVE CONVERGENCE AND FUSIONAL CONVERGENCE.

In order to satisfy the requirements of binocular single vision, the visual axes must converge to the point observed with an astonishing accuracy. But the stimulus of accommodation alone does not normally accomplish all of this divergence, since the cover test at the reading distance shows that the covered eye deviates outward. This outward deviation is the measure of reflex, or fusional, convergence, and should bear a relationship of about 1 to 3 to the total necessary for the point observed. Maddox allowed three quarters of a meter angle of associated convergence for each diopter of accommodation, leaving 0.25 meter angle to be cared for reflexly. The amount of this reflex increases as the fixation point approaches from a distance, except that when it approaches near enough to the eye to tax the accommodation, then accommodative convergence is coordinately stimulated excessively, and thereby furnishes a proportionally greater percentage of the demanded convergence than does fusion.

To measure accommodative convergence, the conditions of dissociated images outside the fusion center, one image being undisturbed as in the tonicity test, must be fulfilled, the eyes must be accommodating and any presbyopia corrected. To this end, the test object should be small in proportion to the visual acuity, to assure the precise accommodation. The small type, 10 or 12 point horizontal line with a short, broad vertical line drawn across its center, but not long enough to be refracted into the fusion area, helps to induce the proper accommodation, and its size and direction assist the patient in determining when their images are properly alined. The strength of the prism necessary for this alinement measures the reflex component of convergence, and the total convergence for the point (3 prism diopters for one-third meter) less the amount of this reflex measures the accommodative convergence. This convergence for one-third meter distance is 3 meter angles, or about 19 prism diopters for each eye. Of this, accommodative convergence supplies normally about 13, and fusion convergence the remaining 6 prism diopters. The asthenopia incident to presbyopia is more often due to disturbed accommodative convergence than to insufficient accommodation. Maddox[6] implies this when he says, "The most important minute of a refractive consultation is that in which we deliberate what reading lens to order."

AMPLITUDE OF CONVERGENCE.

If, while fixing at the near point of accommodation, the double rotating prism, base out, is increased in strength to the point of diplopia, maximum convergence is induced. This, added to the prism divergence for distance, measures the amplitude of convergence, which is normally about 14 meter angles.

DUCTION.

Duction tests taken alone are of little value, but, considered in connection with the other tests, are often invaluable. For example, when the duction tests are found normal in connection with abnormal tonicity, innervational rather than anatomic muscle deficiency may be suspected. The monocular phorometer, with prism base *in*, gradually increased in strength to the point of diplopia, measures adduction; similarly, with base *out*, it measures abduction; with base *up* and *down*, it measures superduction and subduction, respectively. Each test should be repeated until uniform answers assure accuracy. Normally, the external rectus overcomes a prism of 6 or 7 degrees, the internal rectus 12 to 30 degrees, depending on practice, the superior and inferior recti 2 degrees each. The tonicity should be considered in determining the amount of abduction and adduction. The amount of esophoria should be added to abduction and deducted from adduction, and the amount of exophoria deducted from abduction and added to adduction.

FUSIONAL CONVERGENCE.

Fusional convergence should be determined at one-third meter or, rather,

at the ordinary working distance. A vertically placed line of letter of the alphabet holds the patient's attention and helps to induce accommodation. With each eye fixating this object at the working distance, the rotary prism over one eye, base *in*, increasing in strength to the point of diplopia, measures the negative, and the same, base *out*, the positive fusion reserve. The amount of positive fusion reserve is important in cases of excess tonic exophoria and physiologic exophoria, and that of negative reserve in esophoria and convergence excess. According to Landolt, for comfortable vision no more than from one quarter to one third of the amplitude of convergence should be in constant demand.

VERSION.

Version may be determined by the perimeter or tropometer, and, according to the painstaking observation of Duane, the average readings are 53 degrees inward, 43 upward, 51 outward and 63 downward.

CYCLOPHORIA.

Cyclophoria has been given considerable importance in the writings of Savage,[5] who considers it a frequent cause of asthenopia. Impaired action of any one of the ocular muscles may, when the eyes are turned in certain positions, cause cyclophoria—even the lateral muscles; but it is the obliques which, when impaired, cause the greatest tilting of the vertical axes. These axes normally diverge upward, the degree of divergence increasing as the eyes are directed downward, more when directed upward and outward and upward and inward. The divergence in the primary position is about 3 degrees, and increases on convergence of the visual axes. The simplest way to measure the degree of divergence of the vertical axes is with the double prism base horizontal, and a straight horizontal line, the two vertical images tilting downward nasalward indicating a normal tilting of the vertical axes of the eyes outward.

The cyclophoria test is one of the most important heterophoria tests, especially in dealing with the functions of the obliques.

The duction tests in this connection may be applied both at 6 meters and at one-third meter by the use of a Maddox rod with vertical axis over each eye, tilting each rod outward and inward until diplopia is imminent.

FIELD OF FIXATION.

Even slight variations in the field of fixation may have an important significance in determining the pathologic condition present.

While all tests should be made with the eyes in the primary position, it is necessary also to repeat them in the cardinal and oblique positions, where the limitation of motion is most exaggerated, indicating the muscle or group of muscles or the innervation at fault.

The subject of heterophoria was chosen with the hope that the essay may elicit a free discussion and criticism of its contents; that the members of the section may become more concerned with the importance of the rôle of muscle imbalance as the cause of asthenopia, and that the section may be induced to devise some plan for standardizing muscle imbalance tests and adopt a nomenclature of the special terms used in dealing with this vast problem.

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PERIMETRY: VARIABLE FACTORS INFLUENCING THE BREADTH OF THE COLOR FIELDS.

PROF. C. E. FERREE AND GERTRUDE RAND, PH.D.

BRYN MAWR, PA.

This is the first of a series of papers upon perimetry, and deals particularly with the factors upon which thresholds of light and color perception depend. It calls attention to the irregularities of color sensitivity for different colors and for different meridians of the visual field.

The difficulty of getting reproducible results in determinations of the color sensitivity of the peripheral retina is a common complaint among laboratory and clinic workers. The actual distribution of retinal sensitivities is only one of the factors which influence the results of the perimetric or campimetric determination. By varying the conditions under which the work is done, the zones of color sensitivity may be made to have almost any extent within the field of vision, to vary radically in shape, and even to reverse their order of ranking as to breadth.

The difficulty of obtaining reproducible results is so great as to lead many seriously to question the value of the perimetric or campimetric determination in the work of diagnosis. Their value in diagnosing and checking up the course of some of the most serious affections of the eye is readily conceded, however, provided the needed precision can be obtained. The need of greater precision of work in the laboratory, while less important to human welfare, is no less insistent. These combined needs led us several years ago to make a study of the variable factors which influence the chromatic response, the details of which study are still in progress. Some of these factors pertain to the stimulus; some are peculiar to the response of the eye itself. All may be standardized and controlled. The normal eye is highly sensitive and complex in its responses, but not inherently erratic. While the abnormal eye may be more erratic—one of the symptoms, it may be, of its abnormality—there should be, so far as we can see, no essential difference in the technic of testing and studying its functions.

The theory and practice of clinic field taking seems up to the present time to have been based on the following assumptions: (1) The far periphery of the retina is blind to color, that is, there are definite limits or boundaries of the sensitivity to colored light. These may be called the *actual* limits of sensitivity. The limits as determined, the apparent limits, may or may not agree with the actual limits, depending upon the conditions under which the work is done. (2) The factors affecting the apparent limits of sensitivity, when the fields are taken with pigment colors, are the size and the coefficient of reflection of the stimuli employed. A contraction of the fields, taken under standard conditions of control for these two factors, means then an actual change in the distribution of sensitivities. (3) Sensitivity decreases from the center towards the periphery of the retina, in a fairly regular manner in any given meridian, and the rate of decrease for the same color is approximately uniform from meridian to meridian over a considerable range near the limits of sensitivity. Irregularity of contraction, resulting in a change in the shape of the field, is not therefore to be expected as a phenomenon of the normal eye. And (4) the field of sensitivity is wider for blue than for red. The limits of the fields should not then be expected to interlace, or to reverse their order of ranking as to breadth, without some pathologic or other disturbance in the distribution of sensitivities.

A study of the distribution of sensitivities in the peripheral retina and the factors which affect the apparent limits of sensitivity, shows that these assumptions are not correct. The far periphery of the retina is not blind to blue and red, nor is the sensitivity in this part of the retina greater for blue than for red; the decrease of sensitivity from the center towards the periphery of the retina is very irregular in any given meridian, and the rate of

decrease is very different from point to point in the different meridians; the apparent limits of sensitivity are a function not of two but of several variables. All of the field changes noted above as pathologic may occur, and do occur, as the result of nothing more serious than a defective control of the variable factors which affect the sensitivity of the peripheral retina to color.

The variable factors which affect the sensitivity of the peripheral retina to color, and therefore the results of field taking are, so far as we have been able to discover, the wave length and purity of the stimulus, the intensity of the stimulus and the visual angle, length of exposure of the eye, the method of exposure (moving or stationary stimulus), accuracy and steadiness of fixation, the intensity of the general illumination of the retina and its state of adaptation, breadth of pupil, and the brightness of the preexposure and of the background or surrounding field. Only a few of these can be considered in the present series of papers. For the fuller treatment a bibliography is appended. The most important of these factors from the standpoint of the work of the office and clinic are the intensity of the stimulus and the precision of its control, the brightness of the preexposure and of the surrounding field, the intensity of the general illumination, and the accuracy and steadiness of fixation.

In the present paper, the effect of variations in the intensity of the stimulus alone will be discussed. The discussion of the effect of other factors will be given in later papers. Obviously, the effect of any uniformly acting factor on the size and shape of the color fields and their order of ranking as to breadth will depend upon the type of distribution of sensitivities in the peripheral retina. The first step toward an understanding of the normal color fields and their variations under the influence of different conditions of work, therefore, is a study of the distribution of sensitivity in the peripheral retina of the normal eye. Results will be given illustrative of this distribution, and the effect of variations of intensity on the normal color fields will be discussed and explained in terms of these results. In making this selection of a factor, intensity is regarded as typical. That is, whatever is true of the effect of intensity should be, true, also in a general way, of the effect of any other uniformly acting factor which produces large variations in the breadth of the color fields.

THE INTENSITY OF THE STIMULUS.

By a sufficiently wide variation of this factor alone, the fields of color sensitivity may be made to have almost any breadth in the field of vision, to differ radically in shape, and even to change or reverse their order of ranking as to breadth,—changes of a type and magnitude to which the clinician might ascribe a grave and important pathologic significance. For example, with very high intensities of stimulus the limits of red, yellow and blue are coincident with the limits of white light vision. Green can not be made to have so wide an extent. With stimuli of medium intensity, and of the relative energies found in the prismatic spectrum of a Nernst filament, the limits are concentric and in the order from widest to narrowest of red, yellow, blue and green. With stimuli of medium intensities of equal energy (equal physical intensities) the limits of red, yellow and blue interlace or crisscross. The limits for green again are narrower. The limits for pigment stimuli may be either interlacing or concentric in the order from widest to narrowest of red, blue and green; or blue, red and green, depending upon the pigments used and the intensity of light falling upon the perimeter arm.

It seems only fair to conclude, therefore, that the conventional clinic rating of the limits from widest to narrowest in the order of blue, red and green is a function of the relative and absolute intensities of the stimuli employed, as well as of the actual distribution of sensitivities. A change in the intensity of the stimulus not only changes the limits but, because of the irregular distribution of sensitivities in the different meridians, causes a marked change in the shape of the

fields; and because of changes in the ratio of sensitivity to the different colors in the same meridians, a change in their order of ranking as to breadth. Without great precision in the control of intensity, it is obvious that reproducibility of result can not be obtained, and little significance can be attached to extent or shape of field, to order of ranking as to breadth of field, or to any variations from time to time or from person to person in these important features.

The effect of changes in the intensity of the stimulus both on the extent and shape of the color fields varies with the order of magnitude of intensity employed. For medium and low intensities, the effect of a given amount of change is very much greater than for high intensities. This is an obvious corollary of the type of distribution of sensitivities found in the peripheral retina. That is, in passing from the center towards the periphery, the decrease in sensitivity is comparatively slow and gradual in the paracentral retina; it is much faster and more abrupt in the mid pheriphery; and very abrupt in the far periphery. It requires, therefore, comparatively large changes of intensity in stimuli of high intensity, which carry the limits of sensitivity into the far periphery, to produce a significant change in the limits; not so great a change in the stimuli of medium intensity; and a still smaller change in stimuli of low intensity. This effect varies greatly, however, for the same color in the different meridians, and for different colors in the same meridians. For the stimuli of medium and low intensities used in the office and clinic, the effect of change of intensity is very marked indeed, both on the extent and shape of the fields of sensitivity.

We have stated that the order in which the fields may be found to occur, ranked with regard to breadth, depends upon the actual distribution of sensitivities and upon the relative and absolute intensities of the stimuli employed. That it depends upon the relative intensities should be more or less obvious, provided of course that the relative differences of intensity are great enough to overcome or reverse the actual differences in sensitivity. In support of the statement that it depends also on the absolute intensity, maps will be shown in a later paper in which for the same eye and a constant ratio of intensity of stimuli, the limits for red and blue in some cases interlace or crisscross; in others they are concentric or nearly so—the limits for blue lying outside of the limits for red; or conversely the limits of red lying outside of the limits for blue—the difference in result depending solely upon the absolute intensities of the stimuli employed. The determinations were made with the Hering standard pigment papers presented to the eye by means of the perimeter described in a preceding paper,[1] with the preexposure and surrounding field of the brightness of the color, the only variable being the intensity of illumination of the perimeter arm.

The Chromatic Thresholds of Sensation From Center to Periphery of the Retina.

As we have already stated, the effect of such factors as intensity on the extent and shape of the color fields and their order of ranking as to breadth can be better understood when a thoro knowledge is had of the actual distribution of sensitivities from point to point from center to periphery of the retina. In order to show this distribution; we have made determinations of the threshold of sensation (the amount of light required just to arouse the color sensation) with spectrum lights and under proper conditions of control, for the different colors at near lying points in the different meridians. A graphic representation of the results of these determinations for two meridians, the temporal and the nasal, is given in Charts 1-4. In these charts the degree of excentricity is plotted along the horizontal coordinate, and the energy or intensity values of the threshold in watts (10^7 ergs per second) are plotted along the vertical coordinate. The values of the thresholds for blue are represented by the continuous line; for yellow by the dotted line; for red by the dash line; and for green by the dash-dot line. In case of red, yellow

and blue, it will be remembered from statements made earlier in the paper, the limits of sensitivity for lights of high intensities coincide with the limits of white light vision. This, however, was not the case for the green stimulus. By no increase of intensity were we able to make the limits of green sensitivity coincide with the limits of white light vision.

In charts 3 and 4, the above values from the center of the retina, thru the region of gradual decrease of sensitivity, are plotted on a larger scale, a tenfold amplification. This was done, because when plotted on the scale used in charts 1 and 2, the curves fell so closely together, that the relative sensitivities to the four colors are not clearly represented. This is, the range of values for the threshold from the center to the extreme periphery of the retina is so great, that in charts 1 and 2, in which the entire range is represented, a scale value had to be chosen for the vertical coordinate which is so large as almost to obscure the smaller differences in relative sensitivity to the different colors in the paracentral retina, the region of gradual decrease in sensitivity.

Space can not be taken here for a full discussion of the results of these determinations. For a more detailed statement of results and a fuller discussion of their bearing on points of theoretic and practical importance, the reader is referred elsewhere.[20] The following points, however, may be noted in connection with the present paper:

(1) *The great range of sensitivity from the center to the extreme periphery of the retina.* For example, in the temporal meridian the sensitivity to red is 900 times as great at the center as at the extreme periphery of the retina; for yellow 1650, for blue 3280, and for green 3380 times as great.

(2) *The great irregularity in the decrease of sensitivity* which is found in passing from the center to the periphery of the retina. This irregularity, moreover, differs greatly in the different meridians. From these irregularities, it is obvious why the shape as well as the extent of the fields of sensitivity change with the change of intensity of the stimulus light. That is, depending upon the different rates of decrease of sensitivity in the different meridians, a given increase or decrease of intensity of the stimulus light causes respectively different amounts of extension or contraction of the fields in these meridians. The result is, of course, a change of shape of the field proportionate to the amount of irregularity of the distribution of sensitivity in the different meridians.

A further obvious corollary of the irregularity of distribution of sensitivity in the different meridians is the interlacing or crisscrossing of the limits when the stimuli are so graded in intensity as to give the limits for all the colors approximately the same degree of excentricity. That is, a condition of coincident or concentric limits, would presuppose a regularity of distribution of sensitivity from meridian to meridian; irregularity inevitably leads to an intersection or crisscrossing, when the conditions under which the determinations are made are such that the fields have approximately the same breadth. A frequent crisscrossing of the limits, it will be noted in charts to be given in a later paper, occurs for red, yellow and blue, when stimuli of medium intensity and of anywhere near equal energies are used.

(3) A third point is the great *irregularity in the ratio of sensitivity to the different colors,* which is found in the same meridians in passing from the center to the periphery of the retina. At some points, for example, the sensitivity to red is greater than the sensitivity to blue; at others the reverse is true. An obvious corollary of such shift in relative sensitivity is a reversal of the order of breadth of the color fields, a reversal which we have every reason to believe is not pathologic. This does not mean, of course, that reversals in order of breadth may not be of pathologic origin. It does indicate that they may occur in case of the normal eye, as the result of no more serious condition than a change in the absolute intensity of the stimulus light, or translated into terms of ordinary office and clinic practice, a change in the intensity of light falling on the

perimeter arm at the point of work—a change, moreover, no greater than may occur in the illumination of a daylighted room from noon to four o'clock on any bright winter day. That is, as the intensity of the stimulus light changes, the limits fall at different distances from the center of the retina. If they happen to fall in a region where the sensitivity is greater relative distribution of sensitivities, as the case may be. Working under these conditions, we have a chance really to find out what is normal with regard to the breadth and shape of the fields of sensitivity, and their relations for the different colors, and to check up their variations from time to time as the result of the advance or recession of a pathologic condition.

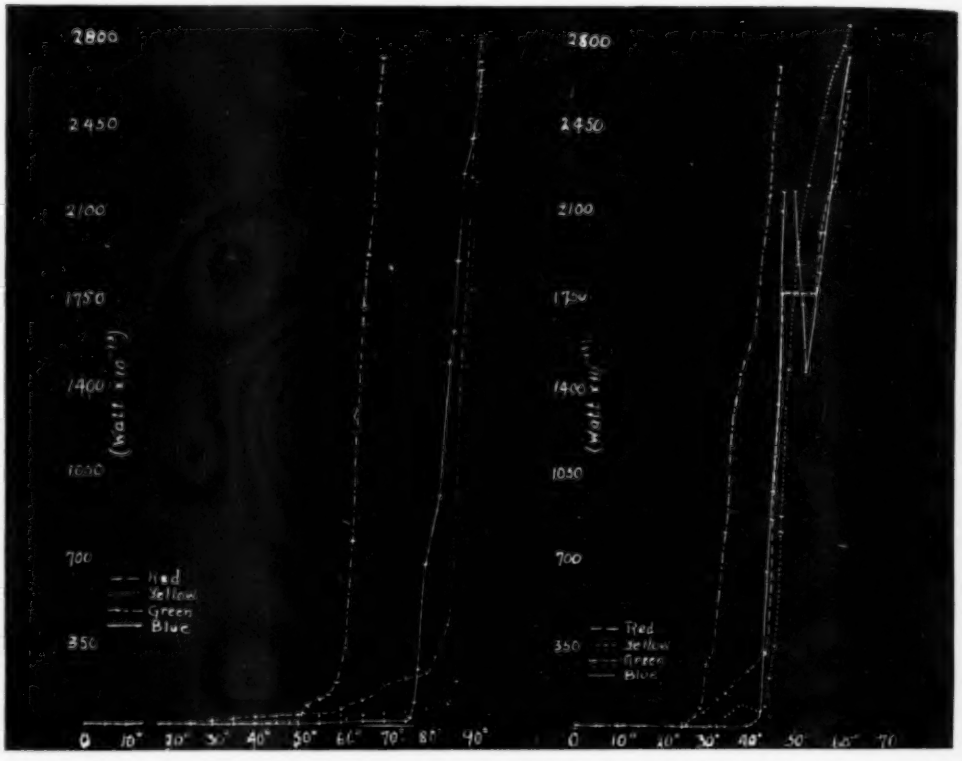

Chart 1. Chromatic thresholds for the four colors, temporal meridians.

Chart 2. Chromatic thresholds for the four colors, nasal meridians.

to red than to blue, the limits for red will be outside the limits for blue; and conversely if they happen to fall in a region where the sensitivity to blue is greater than to red, the limits for blue will lie outside of the limits for red. There is no reason to believe that these irregularities are the same in kind or degree from person to person. Obviously, the only safeguard against misinterpretation either in establishing a norm or in making comparisons with an established norm, is always to work with the same conditions of control. A difference in result will then mean an actual difference in sensitivity or in the

A further corollary of the change in the ratio of sensitivity to the different colors in passing from the center to the periphery of the retina, is the change in hue of red and green. This change is toward yellow when the observation is made with a preexposure and surrounding field of the brightness of the color, and there is a proper control of all other variable factors. If the observation is not made under these conditions, the change may be still more complicated. The change toward yellow depends upon two facts: (a) The red and green wave lengths of light have the power to arouse not

only the sensations of red and green, but also weakly the sensation of yellow; and (b) sensitivity to red and green falls off more rapidly than to yellow in the mid periphery of the retina. In the center of the retina, which is fully sensitive to red and green, the weakly aroused yellow excitation is below the threshold of sensation, i. e., too weak to be sensed in the presence of the strongly aroused red and green sensations. However, in those parts of the periphery of the retina in which the loss of sensitivity to red and green is greater than to yellow, the yellow component of the sensation comes above the threshold, and the red and green stimuli are sensed as yellowish-red and yellowish-green.

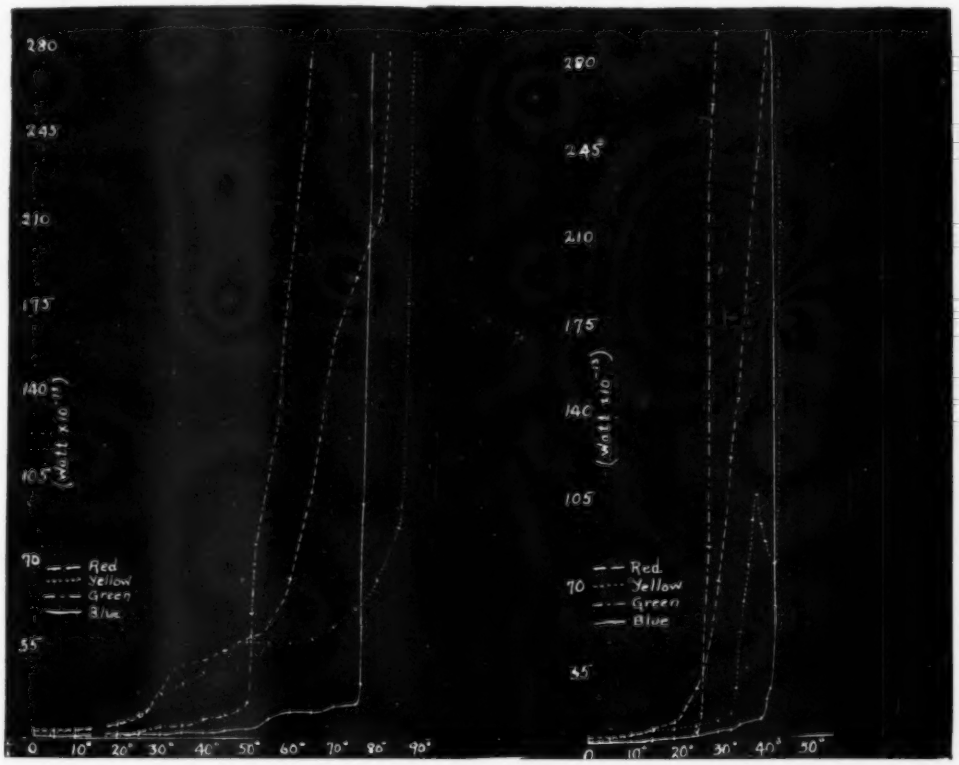

Chart 3. Chromatic thresholds (enlarged scale) for the four colors, temporal meridian.

Chart 4. Chromatic thresholds (enlarged scale) for the four colors nasal meridian.

For example, in passing from the center to the periphery of the retina in the temporal meridian, the red stimulus was sensed as red from the center to about 60° by the observer whose threshold results are given in charts 1-4; from 60° to about 86° it was sensed as yellowish-red or orange; from 86° to the limits of sensitivity it was sensed again as red. Corresponding to this it will be noted (charts 1-4) that there is in this meridian a fairly close agreement in sensitivity to red and yellow from the center to about 60° (stimulus sensed as red), at which point there is a relatively sharp decrease in sensitivity to red. That is, from 60° to 86° there is much less sensitivity to red than to yellow (stimulus sensed as yellowish-red or orange). At about 86° there is a sharp decrease in sensitivity to yellow, and from this point on to the limits, a fairly close agreement again in sensitivity to the two colors (stimulus sensed as red). In the nasal meridian, the red stimulus was sensed as red from the center of the retina to about 30°; from there to about 47° as yellowish-red or orange; and from 47° to the limits of sensitivity, as red. Similarly in this

meridian, there is a fairly close agreement in sensitivity to red and yellow from the center to about 30°; from 30° to about 47° there is a considerably greater sensitivity to yellow than to red; and from this point on to the limits, greater sensitivity to red than to yellow. In case of green, in the temporal meridian the greater loss in sensitivity to green, as compared with yellow, begins at about 51°; and in the nasal meridian at about 26°. Correspondingly, at these points the green stimulus began to be sensed as yellowish-green and continued to be sensed in this hue until the limits of sensitivity to green were reached, from which point on, for a short distance, it was sensed as unsaturated yellow.

These changes of hue are the normal changes for spectrum or pure red and green in passing from the center to the periphery of the retina when, as we have already stated, there is no achromatic effect of preexposure and surrounding field, that is, when the preexposure and surrounding field are a gray of the same brightness as the color, and when the general illumination of the room is held constant. In a later paper, the changes produced by a preexposure and surrounding field lighter or darker than the color, and by a variable illumination will be given.

In chart 2, nasal meridian, a gap will be noted in the curve for blue not present in the curves for the other colors. In this area is represented a peculiar type of color blindness, small areas or spots which are found, so far as we have been able to discover, in all or most peripheral retinas. In these spots, the blindness is to one color alone. The spot is fully sensitive to all of the other colors. Moreover, it shows no deficiency in the cancelling, after image and contrast reactions of the color in question. That is, in this area the stimulus, altho it is not sensed as color, has just as much power to cancel the complementary color and to arouse the complementary colored after image as it has in the immediately surrounding retina. These spots seem not to be subject to change and apparently are not pathologic.

An examination of a large number of observers shows, that eyes may differ widely with regard to the number and size of these spots, their location and the color affected. A successful search of the peripheral retina for the presence of such spots requires a means of making a rather minute investigation of the retina from the center to the periphery in a number of meridians. A more detailed report of the study of this phenomenon has been reported in an earlier paper.[18] F. Schumann[24] reports a case (his own) in which the whole retina is affected by this type of color blindness. In case of these small areas, also in the Schumann case, the defect which renders the eye blind to the color in question seems to be located posterior to the functional level which is the seat of the cancelling, after image and contrast reactions, else these reactions would be disturbed in some proportion to the disturbance in the power to sense the color in the positive sensation. It would be of interest to know whether the cancelling, after image and contrast reactions are retained also in the relative scotomata of pathologic origin. This point will be made the subject of future study.

CONDITIONS UNDER WHICH THE THRESHOLDS WERE DETERMINED.

(1) The colored lights were taken from the spectrum and special precautions were exercised to secure a high degree of purity. There are two reasons for this in an investigation of the kind here undertaken: (a) The stimuli should be as homogeneous as possible with regard to the visible wave lengths. The presence of alien visible wave lengths affects the results of a determination of chromatic sensitivity in two ways. Thru physiologic inhibitions and interactions it decreases the amount of the color response; and it increases the energy measurement. In both of these ways the value of the threshold is raised by the presence of impurities in the stimulus light. And (b) the stimuli should be free from the infrared and ultraviolet radiations, which would affect the thermopile used to measure the intensity of light, but not the eye.

The stimuli employed were a narrow band of red in the region of

670μμ.; of yellow in the region of 581μμ.; of green in the region of 522μμ.; and of blue in the region of 468μμ. The breadth of the analyzing slit used in isolating these bands was maintained constant at 0.5 mm. The ranges of wave lengths obtained were approximately 660-680μμ.; 575-587μμ.; 518-526μμ.; and 464-474μμ. The spectrum was gotten and the different wave lengths were presented to the eye by means of an apparatus[12] already described. In every case the light was examined for impurities at the analyzing slit by means of a small Hilger direct vision spectroscope provided with an illuminated scale. When found, impurities were absorbed by thin gelatins selected so as to cut out as little as possible of the useful light. These gelatins were placed over the analyzing slit and were held in position by short clips fastened to the front surface of the jaws, the edges of which formed the slit.

(2) The determinations of the thresholds were made in energy terms. Measurements were made at two places: at the analyzing slit and at the eye. The method of making the energy measurements by means of a thermopile has been described in previous papers.[25] The values given in charts 1-4 are total amount of light entering the eye.

(3) The field surrounding the stimulus and the preexposure were always maintained as nearly as possible at the same brightness as the stimulus at the threshold value of sensation. These surfaces were made from the Hering standard gray papers. It was found to be necessary to change the brightness of the surrounding field and preexposure frequently for each stimulus, because the brightness value of the color at the chromatic threshold changed quite rapidly from the center toward the periphery of the retina. There were two causes for this change: (a) The intensity of light had to be increased a great deal from center to periphery to give the chromatic threshold from point to point; and (b) the achromatic value of the colors does not remain the same from the center to the periphery of the retina (the Purkinje shift of the peripheral retina). The match of color to gray was made in every case for the point of the retina under investigation.

(4) The illumination of the room was kept at a constant value. Its value on the working surface was 30.49 foot candles. Two features are necessary for this control: (a) A means must be had of detecting small changes of illumination. This may be accomplished by a portable photometer of the Sharp-Millar or Macbeth types furnished with a daylight screen, or of the simpler type described by the writers in a previous paper.[13] And (b) a means must be had also of producing small variations in the illumination of the room, else the changes due to fluctuations in the external light can not be compensated for with the precision and minuteness of control that is needed. This is accomplished in our optics room[28] by two systems of thin white curtains running on spring rollers beneath the skylight. Large changes are produced by a light proof curtain. One of the systems of white curtains and the light proof curtain run lengthwise of the room; the other system of white curtains runs across the room. By means of the white curtains, either small local or small general changes can be produced in the illumination of the room; and by means of the light proof curtain, larger changes may be produced ranging from full illumination to the darkness of a moderately good dark room. The light proof curtain is of a breadth equal to that of the room and runs in a light tight boxing. The white curtains are narrower and are made to overlap at the edges. These latter curtains run on wire guides to prevent wrinkling or sagging. Above these curtains are pivoted two large diffusion sashes of glass, ground on one side completely filling the skylight opening. These sashes diffuse the light in the room, giving an even distribution of illumination and rendering, because of that fact, an even and precise control easier to accomplish.

(5) The results were made independent of the size of the pupil. Breadth of pupil affects the results of

a determination of the sensitivity of the peripheral retina in the following ways: It influences the clearness of imaging, the amount of light entering the eye, and, by limiting the angle at which the beam of light may enter the eye, the degree of excentricity at which an image may be formed on the retina. Independence of change in size of pupil was especially needed in this work, because of the large variations in the intensity of light used. Such control is very easy to accomplish with the means of presenting the light to the eye that is used in our spectroscopic apparatus. All that is needed is to keep the image that falls on the pupil of a constant size and smaller than the pupil thruout its entire range of variations in the given series of experiments. Not only can this variation be determined in preliminary experiments as a guide to the size of image that is needed, but the image itself can be compared with the pupil at each observation.[14]

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NOTES, CASES AND INSTRUMENTS

CABINET FOR GALVANIC ELECTRICITY.

M. E. Smukler, M.D.

PHILADELPHIA.

The increasing use of galvanism by the ophthalmologist has led me to design a simple and economical wall cabinet for those having access to alternating current only.

The practical and economical advantage of this cabinet is, that it is so constructed that the dry cells are concealed, and yet so easily accessible that

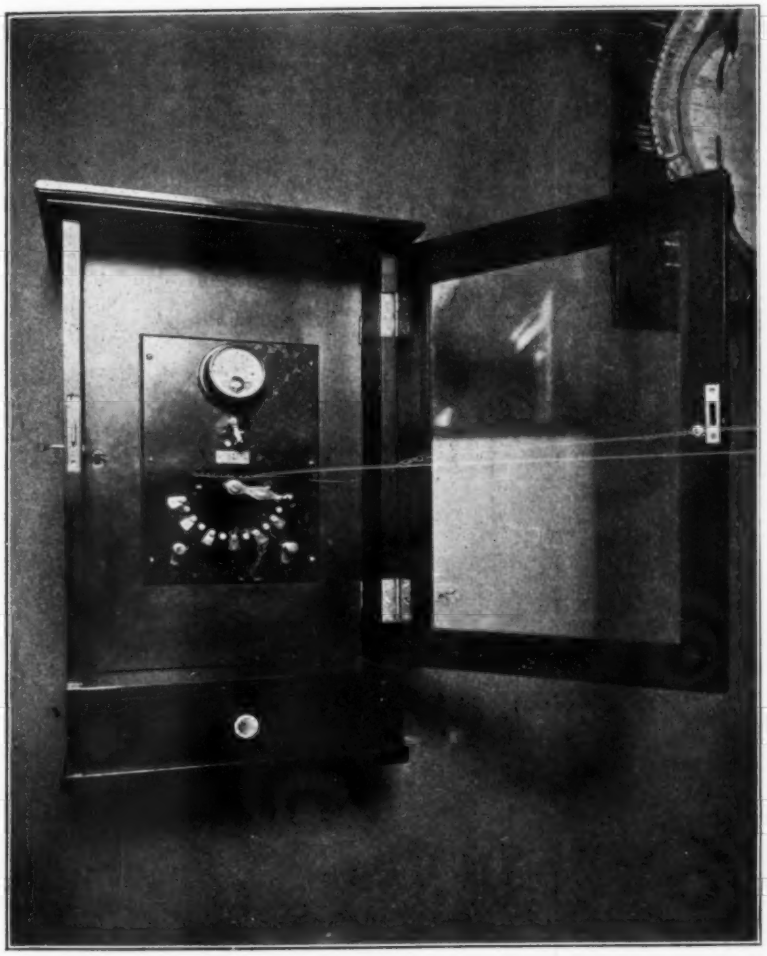

Fig. 1. Cabinet for galvanic electricity showing switch board and galvanometer. (Smukler.)

they can be changed in a few minutes by the physician himself, when the current is exhausted.

This arrangement obviates the necessity of installing an expensive motor generator to change the alternating current into direct current. It is not advisable to use a rectifier to change the alternating into direct current as it produces a pulsating galvanic current (rapid interrupted pulsating galvanic current) which is not suitable for the eye.

The cabinet (Fig. 1) is so constructed, that twelve No. 6 dry cells are housed so that they are concealed by a hinged door (Fig. 2) holding a marble panel, on which is mounted a milliamperemeter with a switch to throw it in or out, a twelve point selector switch, so arranged that the strength of one to twelve cells may be employed at the will of the operator, each successive point adding a cell, and two binding posts.

Below is a drawer for housing accessories. The hinged door has a lock and key.

The cabinet may be used as follows:

1. For negative and positive galvanism, as suggested by Dr. S. Lewis Ziegler. Here it is exceedingly useful, as the current is smooth and continuous, and the dosage the patient gets registers on the meter.

2. To supply the current when using a small Lancaster hand magnet (made to be used with eight or twelve

Fig. 2. Smukler's cabinet open to show arrangement of cells.

dry cells) which requires 12 amperes of current and has the resistance of about 1 ohm.

3. For corneal electrodes—Wirtz or Ziegler's.

4. Various diagnostic lamps.

EIKONOSCOPY.

CHARLES D. JONES, A.B., M.D.
BOSTON.

Criticism of the terms used in ophthalmology to designate what is usually known as the *"shadow test,"* reminds us that we have not yet hit upon any word which really describes this method of examination.

A recent communication criticizes the term, *"retinoscopy,"* arguing with perfect correctness that the details of the retina are not studied in this process. The only other terms in common use, "shadow test" or *"skiascopy,"* are no better. The process is neither a study of the retina nor of shadows: it is a study of images.

Consideration of the technic makes it clear that the whole purpose of the examination is to determine the conjugate focus of the retina; or more precisely, as usually performed, to determine what lens is necessary to reduce the refraction of the eye under examination to a myopia of one diopter, supposing the examination is carried out at a distance of one meter from the patient.

If the conjugate focus of the retina is less than one meter from the eye, the image of an illuminated spot on the retina is real, and necessarily inverted, and moves in a reverse direction. In the language of optics, the image is reversed from the object, the object in this case being the illuminated spot on the retina (or choroid). On the contrary if the conjugate focus is farther than one meter from the eye, the image seen by the observer is virtual and erect, and moves in the same direction with the object.

In making the examination, the character of the image, whether real or virtual, is ignored. It is not practical to determine its shape, nor is it necessary to do so, when the study of its movement gives results far more accurate. These considerations apply to an examination made with the plane mirror. In working with a concave mirror, the results will be reversed, unless the focal length of the mirror is more than one meter, and such long focus mirrors are not used.

It is a bad habit to change old names, but the writer would suggest, inasmuch as the whole process is a study of images, that if a change is to be made, the term, "Eikonoscopy" be selected.

VELONSKIASCOPY DETERMINATION OF PRINCIPAL MERIDIANS OF ASTIGMATISM.

EDWARD J. BROWN, M.D.
MINNEAPOLIS.

Since reading in the March number of Ophthalmic Literature the description of Trantas' subjective shadow test for the determination of the principal meridians of astigmia, a careful test of the method has convinced me that it has great value. Looking intently at a point of light or even a larger light, one passes back and forth before his pupil in the different meridians a probe or wire, and he will see a shadow of the wire passing across the light if he has a refractive error, in myopia with the movement of the wire, and in hyperopia against it. With an intelligent patient who has the faculty of close observation, by trying out the various meridians, first that in which the shadow is most definite and clear cut, and then the meridian at right angles, the exact strength of the required lens, to an eighth of a diopter, and the exact axis of the cylinder may be determined. My observation is that the claims of the discoverer of this method (Trantas) are not overdrawn.

Unfortunately, compartively few of our patients are both intelligent and capable of acute observation. For those who are not so capable, I have found the use of the stenopaic slit much easier and more delicate. With the latter, the light seems to move

either with or against the movement of the slit if there be a refractive error, and a slight but easily detected shadow comes over one or other part of the light. When such movement has disappeared in all meridians, emmetropia has been achieved.

For coarse and rapid work, a light two or three centimeters in diameter may be used, but for fine work, the light should pass thru a screen not over three millimeters in diameter. The wire or the slit should not be wider than one-half millimeter. It is a decided advantage to have the room darkened.

My first patient examined besides myself, was one having over three diopters of mixed astigma, and the nature of the case and the approximate axis of the required cylinders was determined with almost unbelievable celerity. My last case, a young girl wearing R. —4.50 —.25 c. 180; L. —4. —.25 c. 180, V. 20/15 plus, under scopolamin showed definitely with this test: R. —5; L. —4.25—.50 c. 180, and a plus or minus one-eighth in either meridian would cause a reversal of the shadow.

Carrying my modification of the Trantas method of subjective determination of the refraction, and especially of the amount and axis of the astigmia, to its logical conclusion, I have found that a small perforation (1/50 of an inch or 1/2 millimeter) is greatly superior either to the wire (Trantas) or to my stenopaic slit. With such a sight hole in either a thin card or a metal disk, the patient has only to slightly move the perforation in different directions to secure very definite movements of the point of light either against or with the movement of the card. The Trantas method of subjective refraction is especially valuable in cases where, as in a patient whom I examined yesterday, the cornea is so scarred from old pannus that objective skiascopy is of no value.

SOCIETY PROCEEDINGS

Reports for this department should be sent at the earliest date practicable to Dr. Harry S. Gradle, 22 E. Washington St., Chicago, Illinois. These reports should present briefly the important scientific papers and discussions.

DETROIT OPHTHALMOLOGICAL CLUB.

January, 1922.

Dr. Neil Bentley, President.

Accidents in Cataract Operations.

Dr. Eugene Smith: Among the accidents which happen during cataract operations, none is more provoking than loss of vitreous before delivery of the lens, particularly so if dislocation of the lens also happens.

Mr. W., aged 82; sclerosed lens; preliminary iridectomy; eye deep set; slightly unruly patient; incision small; enlarged with scissors; lens wedged in cut. Attempt to aid expulsion with spoon broke off the upper one-third, or one-half of a very friable lens, contraction of the eye muscles caused a loss of a couple of drops of vitreous and dislocation of the lens remnant into the vitreous chamber. Removal with a loop or spoon seemed too dangerous and the eye was dressed as usual after such operations. The case progressed satisfactorily and with very little reaction.

Some time since, I read of a suggestion to let a couple of drops of vitreous escape thru a wound in the sclera and break up i.e. make a discission of the lens thru the posterior capsule; the reduction in amount of vitreous making room for swelling of lens matter, and reducing the danger of subsequent reaction, and on this suggestion I acted. I had also in mind a case seen many years ago in the clinic of Thos. Reid of Glasgow. The operation had been made to promote absorption of senile cataract by discission thru the posterior capsule. The case had the remnant of a hard nucleus swinging in the pupillary space like a teter. It was held in position by slight iritic adhesions and was evidently slowly absorbing. But such cases were slow in recovery.

A rather common accident that may happen in any incision is the getting of a fold of iris over the edge of the knife blade, usually happening just after the counter puncture is made, due to escape of aqueous and pressure of fixation forceps. An entanglement of iris into the angles of the wound when iridectomy is made is much too frequent, due to incomplete toilet; operators being apparently afraid to use the spatula in clearing the angles. Hemorrhage into the vitreous, expulsive hemorrhage, is a horrible accident —I am happy to say very infrequent. I have seen but two cases.

In reporting this case and the slight reference to other accidents, the object has been simply to excite a discussion of the subject.

Discussion. Dr. Maire: All operators who have great experience in cataract operations will occasionally meet with the accidents that Dr. Smith has enumerated. It would be a very good plan to look at the situation from two standpoints. First, in regard to the prevention of accidents by the patients themselves, and also what the operator can do to prevent them. It is a wise precaution to look our patients over before operating. A patient having a cataract, we must not assume it can be disposed of simply by an operation. We have to look at the constitutional condition of the patient, take the blood pressure and his general condition.

The condition of refraction is important. For instance, in a high degree of myopia the chances are not as good for a successful issue, as they would be in a normal case. In case of high myopia, I always have Weber's loop ready to use immediately if the case seems to require it by prolapse of the vitreous. I have never regretted passing the loop in carefully and extracting the lens. If one does not observe this precaution and is not prepared, and tries pressure to extract the lens, he will find in many cases loss of vitreous.

Dr. Parker mentioned a very important thing, that is, a good incision, and would like to add to it a good sharp knife, together with making the counter puncture at the proper place. I think if the corneal incision is made properly, with a good conjunctival flap, our chances, so far as our work is concerned, are very much in favor of a successful operation. If your counter puncture is made so that the knife passes into the sclera, you have made too large an incision, blood in the anterior chamber results and you are a little at sea as to subsequent steps.

I had two cases of cataract operation within two years in St. Mary's Hospital in which there was delayed union. There was some ciliary inflammation, and iritis. I think we will all concede that vomiting after a cataract operation is not conducive to a good result, as a rule. Subsequently, these patients had pretty fair vision.

To my mind there is no more beautiful operation than a cataract operation, when all steps have been taken properly. Some patients are very much agitated, and I make it a rule to talk quietly to them and explain what dangers there are, and how important it is for them to be quiet.

Dr. N. Bentley: I was very much struck with Webster Fox's method of handling the dislocated lens. This of course is not the dislocated lens occurring at the time of the operation, but the cases of dislocated lens that come to him without operating. He makes an incision straight across the cornea; from three to nine o'clock, and then instead of making his knife upward as we do in regular extraction, he makes it straight up towards him, the patient being of course on his back, making the incision straight across the cornea. Then making pressure, the lens comes up very neatly. He had a few operated on there and had others he showed. That incision across the cornea makes a surprisingly small scar, and they get very good vision.

He had one case where the cornea turned back with a marked prolapse of the vitreous. He used the method of snipping off the vitreous prolapse with sharp scissors, and then putting sutures at the edge of the cornea above, and it really held it fairly well.

Dr. Parker has made one suggestion, where the anterior chamber does not close readily, of wiping the

mouth of the wound with 2 per cent silver nitrat, doing it every day, and making a little rubbing at the time to get closure.

One point should be emphasized, and that is the timing the amount of your anesthesia. I have seen bad results where I felt the difficulties were due to the fact that we did not wait long enough to induce anesthesia. It takes at least 10 minutes to induce anesthesia, using the cocain every two or three minutes. I have always been inclined to feel that many cases of iritis following the operation were due really to infection, and I know it is true, that since I have adopted the technic of Smith of India, of using the bichlorid douche prior to the operation, I have very much less iritis.

DR. RAY CONNOR: One cannot see any great number of cataracts extracted without seeing a large variety of mishaps. Even after the patient is safely in bed, the troubles are not entirely over. I remember, in reference to Dr. Wilson's suggestion of a general anesthetic, one patient who had already lost a single eye from a cataract extraction, and who came into the hospital with the distinct understanding that he would not take a local anesthetic. The surgeon consented to chloroform thinking that he would get thru without any nausea, and he succeeded in getting the cataract out very nicely, but shortly after the patient got into bed he had some nausea, and the bandage became stained a brilliant red with blood, and the man lost his eye completely.

Dr. Smith did not mention it, but, of course, we, all of us, have seen cases of mental disturbance. Dr. Parker reported: Following cataract extraction, the patient becomes entirely unruly, and the best thing we can do for him is to uncover his good eye and give him a chance to see that he is not totally blinded. It seems to restore his mental balance better than almost anything else.

DR. WILSON: I suppose nobody has done any considerable number of cataract operations without meeting with considerable number of accidents. One or two points occur to me as worthy of mention. The first is in respect to the matter of anesthesia. Since Koller introduced the use of cocain, in 1884, for local anesthesia, we have practically all of us confined ourselves to that agent as a means of anesthesia in cataract extraction, and I am not at all satisfied that we have always done so wisely.

I have in process of slow and difficult recovery at this time, a cataract patient upon whom I operated several weeks ago, an old gentleman of an extremely nervous type, with some nervous and involuntary trembling motions of his face, chin and body, the type with the heavy superciliary muscle and strong features. I had the patient under observation for some time before the operation, even going so far as to bandage his eye for a few days so he might become used to it, and so that I might see how the eye tolerated the postoperative dressing.

During the extraction, as soon as the cystotomy was made, the lens came forward, as it usually does more or less, but it came forward rather strongly against the inner cornea surface. Before the iridectomy, I removed the speculum. Nevertheless, upon doing the iridectomy, there was a strong contraction of his orbital muscles, and a considerable loss of vitreous occurred, the patient meanwhile making every effort to keep quiet, and making so much effort that he was in a state of tetanic rigidity.

I waited a few minutes and tried to calm him down, talked to him, to get everything quiet, that is, previous to trying the iridectomy, but it was not of any use. Fortunately another spasm occurred, and he extracted his own lens at that moment. I don't know how much vitreous he lost, but I should think at least a drachm. There was quite a fair amount of reaction, but the point of the whole story is this: Should the operator have recognized the probable occurrence of precisely that accident, and employed an anesthetic which would have put him in a state of quietude? We make routine use of cocain as an anesthetic in prac-

tically all cases, where we might, in perhaps a larger number, very appropriately use a general anesthetic and avoid some of these complications.

I am rather of the opinion that as far as immediate and grave accidents occur, marked vitreous losses are our most serious calamities, particularly in patients of the type that I have just mentioned. I am not sure but if a patient is morphinized some of these accidents might be avoided, yet I remember morphinizing a patient many years ago, who vomited so much after the morphin that she lost her eye in consequence.

So far as the incision is concerned, it seems to me that de Wecker's contribution to the whole series of incisions was perhaps the most important and at the same time the most simple. He moved the puncture and counter puncture down practically to the horizontal diameter of the pupil. For a good many years I have not had an incision that was too small, because I almost always began either in the horizontal diameter of the cornea or not more than half a millimeter above it, and I have never seen any reason to regret an incision of that size, the apposition of which is good and the healing rapid and satisfactory. Whether it is as good as enlarging the inner angle of the incision with scissors, I am not sure. It seems to me that when you can do it all at one time, that is better surgery than to do it in two steps, and with scissors which crush the tissues more than a knife does.

I did not know that turning back of the cornea was a very common accident. I had it happen to me once, and it was very surprising at that time. The whole flap turned over like a trap door and the wound was absolutely exposed from one end to the other.

DR. WALDECK: I call to mind one very unusual accident I had in a cataract operation two years ago. It was in a man of 70, a good patient, in whom I obtained a large conjunctival flap. Just at the completion of the extraction of the lens, there was loss of vitreous, which was not, however, a serious loss. The hyaloid membrane was incised and the conjunctiva dressed back and the wound closed. On opening the eye on the first day, it was difficult to elevate the lid. There was very little reaction, the eye was perfectly quiet, but the lid was apparently adherent, altho the chamber was formed and the wound closed. Upon attempting to raise the lid a little bit further to see what the adherence was, the chamber opened, and there was an escape of aqueous, so I immediately desisted. The next day the wound was again closed, and I was able to make a little further exploration, and found that the flap had become turned back onto the cornea and had become adherent to the upper lid. The only explanation I could offer was that in irrigating the eye preparatory to the operation, I had bruised the conjunctiva of the upper lid, so that it was sufficiently denuded to allow the subconjunctival side of the conjunctival flap to become adherent to it. It became so firmly adherent that I was forced to trim it with scissors finally, after many unsuccessful attempts to free it, which resulted in more loss of vitreous, and my ultimate result was rather low vision with some vitreous bands forming. Just what the outcome would have been, I am unable to say, because the patient died within two or three months after the operation.

DR. GRANT: Several years ago I had a Hebrew patient who was very intractable. After I had removed the lens, I had the accident of eversion of the flap. He lost quite a portion of the vitreous, and I was fearful of losing the eye, but fortunately he had good vision afterwards. The accident of having the iris caught on the knife has occurred to me several times, but I have always gone right on as though it was not there, and found it was not much of a disadvantage.

DR. MCCLELLAND: The only couching operation that I ever saw was in Moorefields' years ago. Mr. Treacher Collins was asked to operate upon a patient of Mr. Worth's. Mr. Worth had operated on the other eye and found a fluid vitreous. The eye was promptly lost at the primary incision.

So Mr. Worth asked Mr. Collins to operate on the other eye. He did the couching operation.

DR. SMITH, closing: Dr. Parker speaks about cataract operations without cocain. I recall many years ago the late Dr. McGraw coming in once when I was making a couple of extractions of cataract; he stood and looked at me. This was before the days of cocain. He shook his head, took me aside and said: "Dr. Smith I don't see how you can do it, I don't see how they will submit to it." I said: "Why, doctor, you heard them say they did not feel any pain especially." I was in the habit of using a little trick. With my fixation forceps to steady the eye, I steadied the eye also with one finger pressed against the sclera. At first when the eye was touched there was a movement, but after a moment it became perfectly steady, and many an operation of that kind have I made without local or general anesthesia.

I have made a good many operations with chloroform. I have had my trouble with chloroform from vomiting afterwards, but there is not apt to be as much loss of vitreous from vomiting from chloroform after the old fashioned von Graefe operation, as we might expect with the flap extraction.

With the dislocation downward, it is an easy matter to pass the spoon behind the lens, press the lens against the cornea and lift it with the loop or the spoon — some prefer one, some the other. But when the dislocation is upward and under the upper portion of the wound, what are you going to do? I was called by the late Dr. Goux some years ago to relieve him of just that accident. He had a small wound. In trying to get the lens out, he did not tilt it, but he pressed it directly upward and the result was that it went up and under the upper lip of the incision. It was about two-thirds hidden. When he called me a couple of days after the operation, there was considerable inflammation. I simply opened the wound and pressed the spoon under the lens, reached in and pulled it out.

I have seen loss of vitreous and the lens fall back into the vitreous chamber, in the hands of a number of operators in the Old Country. I recall Liebreich's operation of that kind, the first one I saw him make at St. Thomas' Hospital in London, where he had a large loss of vitreous and fished around for the lens and did not get it, but did get most of the vitreous.

One objection to the old fashioned conjunctival flap; which we have made, gone away from, gone back to again, and then gone away from, is the bleeding which takes place after the conjunctival cut, bleeding into the anterior chamber to such an extent that you cannot see the pupil. You may coax it out, only to have it fill in again.

The bead of vitreous which may appear just before the lens escapes, if the hyaloid is not broken, will many times drop back into position without rupture of the hyaloid if the speculum is lifted. If the hyaloid ruptures, then it is better to remove the speculum and remove the lens before you have pressed it out of its normal position.

Prolapse of the iris, which takes place at the angles of the wound, may not show itself, or, if you have operated by the classical method of flap extraction, you may not find it until you dress your eye three or four days afterwards. Some say, cut it off. I say, no. I say let it remain and heal in the wound. If you cut it off at that time, you are likely to get infection. If you allow it to remain in there, it blocks the wound, it blocks out the microbes so to speak, and it heals in the wound and can be taken care of by a later operation.

The mental condition spoken of by Dr. Connor, we all have met, who have had many operations. The best treatment is to remove the dressing from the fellow eye. In this class, all that I have seen have recovered without any further attacks of insanity.

The first operation I ever saw for cataract was made by couching; I saw quite a number of them. The first three or four operations I ever made for cataract were by couching or depression. There is a difference between

depression and couching. In depression, we press the lens right down in under the vitreous. In couching we put the needle in and press the lens back so that the vitreous comes over it, or press it backwards into the vitreous. In the number of cases that I operated on in my younger days, I never had any bad results. When we used to couch, we pressed the lens down under the vitreous and held it there for a few minutes until the vitreous flowed over it. Then we kept the patient very quiet for a number of days in bed, only to have him get up and see very nicely. That was my experience as a student when my old preceptor used to operate that way.

The wound which Dr. Bentley spoke of seeing Dr. Fox make is the one for cataract suggested by Kuchler, many years ago. He made a transverse incision horizontally across the center of the cornea to extract. Dr. Le Brun, the Frenchman, made his operation, a semicurved linear operation, between the pupillary center of the cornea and the lower portion of the lower periphery of the cornea. Dr. Liebreich made a similar incision between the pupillary border and upper periphery of the cornea, each claiming his own incision, nothing more.

When the keratome is passed in, you can imagine very readily that the outer portion of the wound of the cornea is wider than the inner, and many of us have been in the habit of enlarging that incision when drawing the keratome out, cutting to one side and then to the other with the edge of it, to make the incision the same size on the inside of the cornea.

The subject of accidents in cataract extraction is one which interests us all, and the accident that I had in the case I have reported was a new one to me. A portion of the lens had been removed, and the balance absorbed in the vitreous. It got along so nicely that I thought you all ought to know about it.

Traumatic Aneurysm in Cavernous Sinus.

DR. CARL MCCLELLAND reported the case of Mr. J. M., aged 25, white male laborer, who had swelling of the left eyelid and protrusion of the eyeball. Two weeks before, he was struck in the temporal region on the left side of the head with the sharp end of an ice pick, and pounded over the side of the head with the handle of the pick. He walked three blocks to his home and became unconscious. He was unconscious for 48 hours. The X-ray of the skull showed a punched out hole in the outer table of the skull, where the ice pick had entered; and a linear fracture running back and upward from this point for about an inch and a half. There was no depression over the nose.

Patient regained consciousness a few hours after admittance to the hospital; his temperature and pulse were normal. No paralysis, perfectly clear mentality, no lapse of memory. Temperature and pulse normal. Vision 20/20, negative fundus examination, no swelling of lids or bulging of the eyeball. L. Vision 20/20. Pupil regular and reacts to light and accommodation, eyeball markedly protruded, slightly congested, cornea clear. There was marked chemosis of the conjunctiva, marked swelling and protrusion of both lids, no pulsation.

It was thought at this time that he had an orbital cellulitis. Expectant treatment was used for a few days. The eyeball protruded more and swelling was more intense. Chemosis of the conjunctiva was so intense that it ruptured. Ten days later an attempt was made to drain the orbit. Opening was made along the recti muscles. No pus was found, but there was a large amount of dark blood. Cigarette drains were inserted. This, however, did not give the patient much relief. The vision decreased to practically nil. It was decided to enucleate the eyeball. This was done four days later. There was an unusual amount of bleeding, which we considered should be expected on account of the intense swelling and the inflammation of the tissues. Twice the patient had considerable hemorrhage of the conjunctiva, before the eye was enucleated. Hemorrhage was of sufficient quantity to call the interne,

and it required considerable pressure to stop it. Patient left the hospital in about three weeks. Socket had completely healed. There was great thickening and swelling of both the upper lids and the lower, but no pulsation.

About one week after leaving the hospital, patient came into the office and told me that a few days before he had noticed a beating of the upper lid. Examination showed a characteristic bruit and pulsation of an aneurysm. Pulsation could be felt over the upper lid and the upper part of the socket. Bruit could be heard all around the orbit, but more marked on the frontal and nasal aspect. Dr. W. R. Parker was called in consultation at this time and agreed with me that we were probably dealing with an aneurysm of the cavernous sinus. It was found that pressure upon the common carotid artery with the finger stopped the pulsation and bruit. In September it was decided that the common carotid artery should be ligated; this was done under novocain anesthesia and the pulsation and bruit stopped immediately. Swelling of the lids gradually disappeared under the use of the pressure bandage. Patient is still unable to wear an artificial eye on account of the thickness of the lids. The lower lid is extremely weak and flabby.

Orbital Fracture, Optic Atrophy, Ptosis and Enophthalmos.

Dr. G. M. Waldeck reported: Oct. 1, 1921, patient fell forward on a metal rod, which struck the left eye, perforating the lower lid, denuding the eyeball of conjunctiva on the lower temporal side and above, causing marked ecchymosis and swelling. Patient was sent to the hospital, the upper lid elevated under general anesthesia. Cornea abraded superficially on temporal side from 2 to 5 o'clock. Conjunctiva stripped from eyeball from 5 o'clock upward into fornix. Also lid split at middle, lid margins gaping one cm. No perforating injury of eyeball.

Conjunctiva was sutured into place with seven silk sutures. Also lid sutured. The man made a good recovery in as far as the lid and conjunctival injuries were concerned. However, a ptosis of the upper lid was present, as well as a partial paralysis of the superior and inferior recti muscles. There was a moderate degree of enophthalmos, a thin corneal scar and the optic nerve became pale.

An X-ray was taken of the orbit by Dr. P. M. Hickey, who reported: "On the left side, in the posterior portion of the orbit, near the entrance of the optic nerve, we find a distinct change in the appearance of the foramen. The foramen is thickened at its upper and temporal side. There also appears to be some evidence of extra density of the roof of the orbit, back on the nasal side." A fracture involved the optic foramen, in the cicatrix of which, the optic nerve, as well as some branches of the third cranial nerve had become involved. An operation was deemed inadvisable.

There has been some improvement in the ptosis, so that now he is able to hold the eye fairly well open. He has, however, a complete optic atrophy and the vision is nil.

WASHINGTON INTERNATIONAL CONGRESS, APRIL, 1922.

(*Continued from p. 843*)

Light Sense, Practical Significance of its Variation.

Archibald Stanley Percival, M. B., Newcastle-on-Tyne, England, being absent, his paper was presented by Dr. A. Duane, of New York.

Light sense is the faculty of recognizing different luminous intensities. Too little attention has been paid to the sensibility of the eye to variations in the light stimulus, altho this may be of extreme importance in certain services. A man may have a visual acuity of 6/6, and yet unless we examine his light sense, we may miss the fact that he is night blind. Of what use is such a man, when on watch at sea, in detecting a derelict or

an iceberg, in the ship's course at night?

At nightfall, red colors become much darker, a red geranium will appear quite black, altho yellow and blue flowers can still be seen. Finally as the darkness deepens, blue disappears, and one becomes totally color blind. This successive disappearance of colors is called Purkinje's phenomenon.

When this scotopia is reached, one can still dimly see objects by their differing depths of greyness, but it will be found that one sees best by looking a little to one side of them. Arago first called attention of astronomers to this point telling them that they could best get a glimpse of a very faint star by looking a few degrees away from it. It will be found in complete scotopia the fovea is a blind spot, i. e., there is a central scotoma in the rod free area of the retina.

The visual acuity or form sense diminishes rapidly from the fovea towards the periphery. Acuity of 6/6, at 5 degrees distance becomes 6/24, at 10 degrees, 4/60, and so on. In a very dim illumination, light sense is absent at the fovea, and is at a maximum about 10 degrees from the fovea. One is therefore led to think that rods, or something associated with rods, must be the percipient elements for light sense.

Nocturnal animals possess an excessive number of rods, which are especially long, and a very ill developed fovea, whereas diurnal animals have a well developed fovea and a far greater number of cones. Diurnal lizards possess only cones, while the nocturnal lizards have only rods.

When we pass from bright sunlight to a very dimly lighted room, we can see nothing until our eyes have become scotopic, or adapted to the dark. In order to obtain full dark room adaptation, it is necessary to remain in an absolutely dark room for three-quarters of an hour or so, and then some very curious phenomena are found. In scotopia the light sense is about twice as great with both eyes as with only one. If an object be illuminated by a dim composite light, the retinal sensibility is proportional to the square root of the areas stimulated. In light adapted eyes there is no such binocular summation of stimuli, nor, if the retinal areas stimulated exceeds 1′, is there any increase of brightness from stimulating a larger area.

If you try putting up a fine wire, 16 feet long, horizontally against the sky, you will see it quite easily at a considerable distance, but if you block out from your view all but a foot of it, you will not see it at all, as its effect on your retinal sensibility is only one-fourth of what it was, thus showing that as it obeys the square root areas law, it must be a light sense not a form sense test. Most of our socalled form sense tests are really composite tests of our light sense also, as, for instance, especially the common dot tests and even Landolt's excellent broken ring tests.

Now visual purple or rhodopsin occurs in the rods only, and there is good evidence to show that rhodopsin plays a very important part in the physiology of light sense. When a spectrum of very low intensity is viewed in the dark by a scotopic eye, it appears as a colorless gray streak, the brightest part of which is in the green.

Light sense is tested in two different ways: (1) The discovery of the smallest quantity of light that can be recognized on a black background. This is called the *light minimum* test, and is always referred to as L. M.; and (2) the smallest difference of illumination that can be appreciated between two sources of nearly equal luminosity. This is called the *light difference* test, and is always denoted by L. D.

Now the important practical point is, that the sense for L. M. is always most affected if the receptive part of the retina is most implicated, i. e., in affections of the bacillary layer, the visual purple, and the choroid, on which the efficiency of the visual purple depends, whereas the sense for L. D. fails if the *conductive* part of the visual function is primarily at fault. For instance, in optic neuritis and in retrobulbar neuritis L. D. is at fault. L. D. fails also when the nerve fibrils in the retina are chiefly affected. This I have only recently found out. In all previous publications that I have seen on the subject, it has been

stated that defective light difference was diagnostic of a lesion in the optic nerve. This hasty assumption was no doubt due to the very troublesome apparatus that was used for testing light sense. With my simple little rotating discs, the whole examination need not take longer than three minutes, and so more experience of the diagnostic value of light sense phenomena can be gained in a week's hospital practice than could be formerly attained in a year, unless one's whole time were devoted to the subject.

Dr. Traquair, to whom I pointed out my difficulty, suggested the association of L. D. defects with lesions of the conducting apparatus, instead of simply confining them to those of the optic nerve. I have verified this suggestion by finding L. D. defects in several cases of retinitis. I now think that if the superficial layers of the retina are affected, a L. D. defect will be found, but if the deeper layer (of the rods and cones) or if the choroid be at fault, there will be a L. M. defect.

In all the cases of early glaucoma that I have examined in this way, I have found a L. M. defect as the earliest symptom, and that it was afterward followed by a L. D. defect. I suggested as an explanation of this, that the bacillary layer is more sensitive to slight pressure than the nerve fibers. My observations need confirmation, and I would be exceedingly grateful to any of you if you can confirm or refute them. It is most important to obtain a really reliable indication of the first onset of chronic glaucoma, and I believe that the light sense test will be found to be far more trustworthy than any single tonometric reading.

In cases of early cataract or hazy media, when no details of the fundus can be seen with the ophthalmoscope, it is often of extreme importance to obtain some indications of the condition of the structures at the back of the eye. An examination of the light sense of the patient helps us out of the difficulty.

Two months ago I was consulted by a new patient, for cataract, who told me that now she was quite sure that her right eye was ready for operation, but on testing her light sense I found that both L. M. and L. D. perception were very defective, especially her L. M. I concluded that there was probably a macular hemorrhage present, as projection was fairly good. The light sense test saved a disastrous operation.

We know that unlike form sense, light sense is fairly good even to the periphery of the field, and this peripheral or rod vision is of far more importance than most people think. All must have noticed how very readily one notices a movement of any object in the peripheral field, and so the eyes are turned in that direction to see clearly with the macula what it is. Indeed, as the projection from the periphery is so good, it is often unnecessary to turn one's eyes toward the object. In a town one avoids bumping up against passers-by not by macular vision, but by peripheral or rod vision, i. e., by light sense, not by form sense. Without good light sense, one will not see what to look at. The British Board of Trade ordains that seamen should pass a very high standard of tests for macular visual acuity, but pays little regard to light sense. Quickness of sight —to see an iceberg in twilight for instance—is what is wanted, not ability to determine details about its shape that subtend angles of one minute.

Light sense is the most primitive of the visual functions, and is therefore the last to be lost in ordinary cases of amblyopia. At any rate, in children with an amblyopic squinting eye, in which the form sense may be diminished to 6/36 or even less, light sense will usually be found very good, often better than in the normal eye; however, in later life this extraordinary light perception seems to be lost.

Light Sense Test

Percival's test can be made in ordinary daylight by rotating the celluloid discs on any convenient motor, or by spinning them on an ordinary needle.

L. M. Discs: There are two black discs, on each of which are three white sectors of different sizes: when one of these discs is rotated, three lighter rings are seen, of which the inner is the lightest. On the disc with the large sectors, the inner ring denotes a L. M. of 1/12.5; the intermediate ring, 1/25; the outer,

1/50. This it is more convenient to denote by 12.5, 25, and 50, as ability to see the outer ring denotes a better light minimum sense than that which can only see the inner ring. Similarly, the disc with the smaller sectors denotes L. M. of values 50, 100, and 200.

L. D. Discs: These are white discs, with black sectors of correspondingly different sizes, and when rotated indicate the light difference sense for values of 12.5, 25, 50 and 50, 100, and 200.

It will be noticed that a light sense of either kind, of value 50, is given twice; this is often useful in forming an opinion of the reliabilty of the statements of the patient.

It will be found that few can distinguish the faint grey ring that corresponds to L. D. = 200, and so I assume that the standard for L. D. is 100, while that for L. M. is 200.

It might be hastily assumed that the size of the black sector denoting L. D. = 100 should be of angular aperture 360/100 degrees or 3° 36′, but as Abney has shown us that 5% of the incident light is reflected from lampblack, we must add 1/19 to the angle, so that this sector must be 3° 47′ 22″; similar additions have been given to the other sectors.

Contributions to Ophthalmology.

C. E. FERREE and G. RAND, Bryn Mawr, Pa., discussed the following topics:

I. *An Illuminated Perimeter with Campimeter Features.* This instrument was devised in response to a request by the American Ophthalmological Society for a feasible means of illuminating the perimeter arm with a light of good intensity and quality, so that every point on the arm, in any meridian in which it may be placed, shall receive equal intensities of light. Other special features of the instrument are a carefully standardized control of brightness of preexposure and surrounding field; a provision for an accurate control of fixation both for the normal eye and eyes having a central scotoma; a device for mapping central scotomata; a tangent screen for mapping the blind spot and paracentral and peripheral scotomata, which can be readily attached and removed from the stimulus carriage; devices for the control of fixation in high myopia and presbyopia and a provision for taking the field, if desired, with the eye corected for errors in refraction, etc.

II. *Variable Factors Which Influence the Color Fields.* These are the wave length and purity of the stimulus, the intensity of the stimulus and the visual angle, length of exposure of the eye, the method of exposure (moving or stationary stimulus), accuracy and steadiness of fixation, the intensity of the general illumination of the retina and its state of adaptation, breadth of pupil, and the brightness of the preexposure and surrounding field. The most important of these, from the standpoint of the work of the office and clinic, are the intensity of the stimulus, the brightness of the preexposure and surrounding field, the intensity of the general illumination, and the accuracy and steadiness of fixation.

III. *The Acuity Lantern.* This apparatus, devised in response to a request by the Eye Division of the U. S. Naval Hospital, for a means of making a quick and accurate test of acuity at low illuminations, has been elaborated to serve the following purposes in office and clinic work: (a) for testing acuity with a means of varying, controlling and specifying the amounts of light used over a wide range of intensity; (b) for determining the exact amount and location of an astigmatism with great delicacy and precision, and for using at will either illumination or the visual angle scale for the detection of errors in refraction or for their correction; (c) for testing the light and color sense in terms of the amount of light required just to arouse the light and color sensations; and (d) for varying independently the saturation and brightness of a color, and for color mixing. The use of the illumination scale for the detection of errors in refraction or in their correction was discussed, and a comparison is made of the sensitivity of the illumination and the visual angle scales.

IV. *Effect of Varying Intensity and Composition of Light on Acuity,* speed of discrimination, speed of accommodation and other important ocular functions. The purpose of this study is to broaden our understanding of clear see-

ing and the factors upon which it depends, and to enlarge our knowledge of the principles and possibilities of functional testing in relation to diagnosis and other important application.

V. *Illumination of Test Charts.* The question of the most favorable intensity of illumination is discussed in relation to the three important applications of acuity testing; diagnosis, vocational selection, and hygiene or welfare work on the eye.

Diagnosis of Errors of Refraction by Stenopaic Slit and Clock Dial.

DR. EMILE JUNES, Sfax, Tunis. When one puts in the trial frame a stenopaic slit and looks at the clock dial at 5 meters, it is seen only by the rays passing in the one meridian. If these rays have their focus on the retina (emmetropic refraction), all the lines of the dial are seen with the same clearness. But if the focus falls before or behind the retina (ametropic refraction), the appearance of the dial changes, and the eye distinguishes clearly only in one diameter (or group of two or three diameters immediately adjoining), that which is located in the direction of the meridian exposed; while the others offer an appearance more or less confused. The application of this allows us very simply to measure the error of refraction.

The technic of the method was explained in detail: 1. When the patient sees clearly all the lines on the clock dial. 2. Where only one line or group of lines are seen clearly. 3. Where none of the lines are seen clearly.

Advantages of the method are: It calls for no new apparatus. Rather it simplifies the existing tools, because of the simplicity and clearness of the optic phenomena which characterize it. It is susceptible of universal use, and permits the rapid diagnosis and exact measurement of ametropia, whatever be the state of refraction, the intelligence, the degree of learning, and the nationality of the subject and examiner. Its superiority shines forth especially with regard to astigmatism. It can render the greatest services in all cases where the objective method is practically impossible; for example, in the army, the country, etc.

Anomalies of Ocular Development and Pigmentation.

DR. J. GRAY CLEGG, Manchester, England, reported: Case I. Bilateral symmetric congenital *corectopia* with *iridodonesis* and *microcoria, microlentis* and *coloboma lentis.*

The patient, a male, aged fifty-eight, always had poor sight. Worked as stoker and engine tender. Could not see enough to gain much at school. One half-brother and two half-sisters, all by one mother. All have good sight except the brother, who is shortsighted and wears glasses. No other member of family had eye trouble except one with squint. Patient has five daughters and one son. All have normal eyes.

Sight got better as he grew older until forty-six or so, but since then worse. Could just read newspaper with the left eye by holding near face and screwing eyelids up. Could only see headings of newspaper with the right. Never could obtain glasses to help. Came under my care about June, 1921, because he frequently ran against people in the street.

Cornea clear, but a trifle smaller than normal. Diameter, 10 mm. vertically by 11 mm. horizontally. Anterior chambers rather deep. Plane of irides flat and coronal. The tissue of the iris thin, but thickened in immediate neighborhood of the pupils. Pupils reacted definitely to light. Drugs had no marked effect on the pupils, except that atropin alone brought about some dilatation, increasing the pupillary area to double its ordinary size.

It was impossible to see thru the pupils with the ophthalmoscope, but they lighted up well by transillumination, showing as small, irregular sided slits, the pupillary margins of the iris roughly dovetailing their prominence and fissures when contracting.

With a strong loupe, the stretched iris tissue appears as irregular alternating bands of blue and brown, but the tissue surrounding the pupil is finely radially furrowed, and of a light brown tint.

V. R. E. + 3 D. sph. = J. 20; V. L. E., 6/60; with + 3 D. sph. = J. 20. Iridectomy inner side gave a good hole in the iris, somewhat square in shape. A week later the lens appeared in the anterior chamber, completely opaque, cal-

careous, with small coloboma below. Next day, the lens slipped back into the vitreous cavity; could not be seen by the ophthalmoscope. A day, the lens again in the anterior chamber. Patient kept on right side. Lens 5 mm. in diameter with coloboma below. Under a local anesthetic, a section of the cornea was made up and out. Lens spooned out. In the process the capsule was ruptured partially. Whole drawn out by forceps; atropin instilled. A week later, some swelling of lids, slight injection, chemosis of the conjunctiva. Keratitis striata. Fair anterior chamber. Coloboma larger than before extraction of lens.

A month after operation: Right palpebral fissure smaller than left. Slight redness of skin of lids. Merest trace of limbal injection. Wound perfectly healed. Cornea bright. Fair anterior chamber. The new pupil is absolutely black. The original pupil is almost closed by sphincter and shows as black, irregular line only. V. R. E. + 9 D. sph. ⊃ + 2 D. cyl. ax. 15° = 6/36; + 16 D. sph. ⊃ + 2. D. cyl. 15° = J. 8. Vitreous clear. Disc is somewhat blurred at margin. Staphyloma posterior at disc, 1/2 diameter in width. Superior temporal retinal veins tortuous. No other fundal lesion. The left field shows slight contraction, but the right is normal. There is no scotoma. Tension normal.

Case II. *Melanosis* of the eye, skin of right side of head, and right palate. E. M. R., female, aged twelve. One sister aged ten; one sister aged seven, all healthy. One half-brother, seven months, quite well. No history of any abnormal pigmentation in two maternal uncles, eight maternal aunts, three paternal uncles, two paternal aunts. Has numerous cousins, all well. Patient had slight scarlet fever and varicella.

There is an extensive patch of pigmentation of the skin of the right side of the head, affecting the upper part of the cheek, the temple, and the skin of the scalp, reaching nearly to the vertex. The density of the pigmentation is not uniform, and it resembles the color of a blue black ink splash. The edges of the area are irregular and not sharply defined. The skin is not swollen and does not fade on pressure. There is no nevoid condition.

A similar pigmentation is found on the right palate, with indistinct margins, and a less deeply pigmented area is seen in the mucous membrane of the right cheek. The patch on side of cheek and temple fades a little when weather is fine, and gets darker when wet. The pigmentation was present at birth and has not changed. No other abnormal pigmentation is discernible.

The right globe presents the most striking feature of the case. It is somewhat enlarged, and divergent to the extent of some 15 degrees. The palpebral fissure is a trifle wider than the left, exposing the sclera below for about 1 mm. The conjunctiva itself is not affected. The ocular portion is free from any abnormal adhesions to the episcleral tissue. The latter presents extensive areas of brown black pigmentation. Two of the better defined areas are distinctly swollen to the extent of 1 mm., viz., the large one below the cornea and a smaller one above. The cornea shows in a small central area fine superficial pitting, but it is otherwise clear. The anterior chamber is rather shallow. The surface of the iris is a stippled dark brown, as seen in the brown eyes of dark races. There are two areas of brownish, gelatinous material, apparently lying on it, both of which extend slightly over the pupillary margin. The anterior capsule and cortex are clear. Some bluish opacity in the nucleus of the lens is easily seen. No red reflection is obtained by the ophthalmoscope. V. R. E. No. 1. p. No lighting of pupil by transillumination. T + 1.

The left eye is normal in every respect and its field good. The thyroid is large; some thrill felt on pressure on gland. Impairment of resonance with some collapse of the lung at the right apex, but no evidence of active disease. There is a deep seated mass in the right hypochrondrium, which is moderately tender on pressure (glands?). Vascular and nervous system normal.

Mercurials and Salvarsan for Eczematous Conjunctivitis and Keratitis.

Dr. Antonio Torres Estrada, Mexico City, pointed out that eczematous,

strumous or impetiginous conjunctivitis takes on at times a grave character, on account of the lesions caused to the cornea. Its etiology is at present unknown. But among the causes that are productive of such trouble have been noted:

A. Constitutional causes, scrofula, bad feeding, bad hygiene.

B. Toxic, gastric or intestinal autointoxication.

C. Infections, action of tuberculous toxins from some distant focus.

D. Parasites. Phthiriasis, oxyurides.

E. Neurotrophic.

The author brings out the frequency of syphilis in patients that have these forms of conjunctivitis, a fact that has been rarely mentioned; also their association with syphilitic conditions, such as interstitial keratitis, scleritis and iridocyclitis. The classic treatment based on collyria with mercurials (calomel, yellow oxid of mercury) is insufficient in severe cases. The hygienic measures, which constitute the general treatment, are as insufficient as the local treatment. There does not exist at the present time a general treatment that is specific and active.

Mercury introduced into the organism has a decidedly favorable action on the disease. This, and a marked frequency of coexisting syphilis, suggested the testing of other antisyphilitic remedies. He found that the derivatives of salvarsan were superior to the action of mercury. The author offers the hypothesis that in many cases the cause may be syphilis. But at present he does not think there is sufficient evidence to prove this, especially since there exist such important facts in favor of the tuberculosis theory. He reported three cases.

Instillation of Novarsenobillon for Resistant Syphilitic Interstitial Keratitis.

Dr. Arnold Renshaw, Manchester, England, being absent, Dr. J. Gray Clegg of the same city presented his paper.

In any extensive series of cases of luetic interstitial keratitis, one comes across a number which are very resistant to ordinary mercurial treatment. At the Royal Eye Hospital in Manchester, these cases, and in fact most of the ordinary type, are submitted to treatment by means of salvarsan or its derivatives, novarsenobillon, neosalvarsan or neokharsivan. One is able to distinguish three types:

(1) Which rapidly improves under combined mercurial and arsenical treatment.

(2) Rapidly improves but subsequently relapses under this treatment.

(3) Even after prolonged administration of mercury, iodides and salvarsan derivatives fail to improve in so far as the infiltration of the cornea is concerned. Having noted that a definite ground glass or hazy appearance of the cornea persisted even after twelve to fifteen injections of novarsenobillon or neokharsivan, it occurred to me that the direct instillation of concentrated solutions of the novarsenobillon might be of use. A 1% solution of N. A. B. in distilled water was prepared, and instilled into the conjunctival sacs of the eyes of rabbits. The results were examined by Dr. Clegg and myself, and he decided that there appeared to be nothing to contraindicate its use in children. Accordingly a number of patients were submitted to me by him for this method of local treatment.

Subsequently, other members of the honorary staff of the Manchester Royal Eye Hospital sent along cases for similar applications. All the above mentioned types have been dealt with—namely, the early type, the relapsing type and the resistant type. In the two former types, general antisyphilitic treatment was in its earlier stage, and it is difficult to appraise in a scientific manner the exact value of the local treatment with regard to the improvement found.

Its effect was more to be noticed therefore in the resistant type, which had been treated so thoroughly with mercury, iodides and salvarsan derivatives, that one became almost hopeless of any further good resulting. Instillations have been continued over a period of months from the cessation of general treatment by salvarsan derivatives.

Method. A few drops of 1% solution of novarsenobillon derivatives in distilled water were dropped into the eyes, usually at intervals of seven days, but in the

later stage the interval has been 14 days. The total number of cases treated was 20.

The immediate effect of instillation is a slight hyperemia at the corneal limbus. The patients usually complain only of slight irritation, but the lacrimal secretion is increased temporarily.

The patient is recumbent during the application, and is told to roll the eyeball about so as to get a uniform concentration of the drug, and the drops are added slowly, preferably until the dilatation of the circumcorneal vessels is well marked. The effects consist chiefly of some slight alleviation of the photophobia in the earlier cases, manifest after two or three weeks. Secondly, in the more resistant cases in which intravenous injections have been abandoned, the corneal haze gradually disappears and the substantia propria becomes comparatively clear. The cornea resumes its transparency first at the periphery, and usually the upper part of the cornea clears before the lower part. The disappearance of the corneal infiltration is of course associated with much improved vision, and one patient under this form of treatment can now thread with ease a very fine needle, whereas previously she could scarcely detect hand movements. The effect in all cases has been to reduce the degree of corneal infiltration; and in relapsing cases to subdue the local inflammation.

Ill Effects. So far as can be ascertained no ill effects are produced. In one case only, a very difficult one, which had resisted all forms of treatment, a slight corneal ulcer formed and perforation occurred, but this might have happened quite apart from this form of treatment, and the patient made a good recovery, the cornea eventually clearing very well except for a small scar of the ulcer at the perforation site.

Conclusion. In conclusion, this method is, I believe, a very valuable adjunct to the usual treatment; further this method can be continued when further intravenous injections become dangerous.

It should, however, be used only as an adjunct to general systematic treatment of the disease.

It is interesting to speculate as to whether spirochetae are actually present in the cornea, and if so whether their persistence is due to the lack of blood supply to this tissue.

I wish to express my indebtedness to the courtesy of Dr. Clegg, who has specially asisted in this investigation, and to the other members of the honorary staff, who have also submitted their cases for this treatment.

Treatment of Infectious Keratitis by Vaccines.

Dr. Rovirosa Virgilli, Madrid, Spain, reported further experiences with the methods of treatment, to which attention was called in his earlier communication, in 1915. He sets forth results of practical importance secured in the treatment of ocular disease with vaccines, and especially the *staphylococcus vaccine* in suppurative keratitis. The results obtained in this class of ulcers are truly notable. In all the cases of keratitis so treated, there were observed rapid cicatrization, absence of scarring, and preservation of function in the greater part of the cases.

The vaccines deserve to occupy the first place in the treatment of ulcerative keratitis. All cases here reported were presented to the students of the faculty of San Carlos by Dr. Mayoral, Professor of Medicine. Preference is given to the polyvalent stock vaccines as more immediately available, convenient and less expensive. In case they are ineffective, autovaccines may be used as soon as they can be prepared. When in place of serums we employ vaccines, toxins are injected that compel a reaction on the part of the organism, that produces antibodies which destroy the germs and neutralize their toxins. The treatment is compatible with other measures, local or general, that experience has sanctioned. They rally the cooperation of the whole organism to the process of local cure.

The first cases cited were cases of panophthalmitis, in which enucleation had been advised, but under vaccine treatment retained their eyeballs. Two were staphylococcus infections, and the third presented a diphtheroid bacillus.

A fourth case presented corneal ulcers which healed promptly, with little scarring and good vision. The organism was a pyogenic staphylococcus. In serpent ulcer, there was an excellent result from pneumococcic vaccine, but there had occurred perforation of the cornea. Among the cases of marginal blepharitis, all were benefited, mostly by staphylococcus vaccine, but in one case by an autovaccine containing streptococcus.

Nineteen cases were reported in brief outline, all progressing favorably to good results. There were also thirteen cases of suppurating ulcer of the cornea given in similar outline, that seem to show marked benefit. These included some due to Petit's diplobacillus. The practical applications of immunity and the combination of factors that produce it were discussed.

Carcinoma of the Choroid.

ALLEN GREENWOOD, Boston. Metastatic carcinoma of the choroid is such an infrequent manifestation of a general carcinosis, that the chance to see and follow more than one case but rarely falls to the lot of an ophthalmologist. The opportunity which has come to the author to follow four cases makes it seem worth while to publish them.

CASE 1, first came to the hospital on account of acute glaucoma in the left eye. The fundus showed a separation of the retina in the upper temporal quadrant covering a flat, grayish white mass. A diagnosis was made of sarcoma of the choroid, but the eye was not removed as it was suspected that other organs were involved, particularly the liver. The ocular pain was easily controlled by cocain and miotics. The autopsy findings indicate the prostate as the original source of the general carcinosis. The organs particularly involved in the general disease were the lungs, pleura, peribronchial lymph glands, the liver, the brain and the eye. The eye condition was the first to call attention to the possibility of disease in other parts of the body.

CASE 2. Miss. J. D., age 48, cook. Came under observation April 12, 1908, with the history that the sight in the left eye had been dim for several months, and lately had grown very much worse. Right eye, vision = 20/20 and fundus normal. Left eye had vision of hand motions only in outer field. Fundus showed a retinal separation in the outer part, extending up to the disc and including most of the upper and lower parts as well. Thru the separated retina, 3 d.d. temporally from the disc, could be seen a white mass, elevated centrally about 3 D., which gradually flattened out in all directions. The tumor was quite white in the most elevated portion, giving the appearance as tho a disc of some substance like cheese had been inserted under the retina.

Immediately the similarity of the fundus picture to that seen in case one came to mind, and questioning the patient brought out the history that for a year there had been a hard lump in the left breast, and she had become very short of breath. She had seen no physician, so was sent to one, who reported cancer of left breast, involving left lung and the axillary glands; therefore, inoperable. A weak solution of pilocarpin was ordered for use daily.

The patient was seen again August 4, 1908, complaining that the right eye had a spot of dimness. Right eye examination showed up and out from the disc a whitish, flat mass, about 2 d.d. in size, with retina over it elevated 1 D. This tumor beneath the retina corresponded in all but size to the one seen in the left eye in April. The left eye showed at this time complete retinal separation and opaque striæ in lens. Tension was normal in both eyes. I next saw the patient in consultation at the Waltham Hospital in October, 1908, she having been taken there on account of her weakened general and mental condition. I found her semiconscious and incoherent. The tumor mass in the right eye had increased to more than double its former size, and was elevated at its highest point 4 D. and extended to the disc.

The left eye showed a retinal separation up against a cloudy lens. The patient died several weeks later from cerebral involvement.

CASE 3. Mrs. J. S., age 60. Seen September 12, 1912, at her home, as she was too feeble to come to the office. Patient gave a history of vision failing for several months, beginning first in the

left eye and shortly after in the right. Two years before, had been thru an amputation of the right breast and dissection of the axilla for carcinoma. Had been losing strength, and had a harsh, dry cough with much shortness of breath.

Examination showed, right eye, a flat retinal separation out and down. Retina elevated 3 D. about 4 d.d. down and out from disc, with the elevation growing less as one looked toward the disc, or peripherally. A white discoid tumor mass could be seen thru the overlying retina, but no independent vessels were to be seen and no inflammatory reaction present. Left eye fundus showed extensive separation of the retina from the disc outward, and extending somewhat to the nasal side above and below the disc. The lower part of the separation was billowed forward by exudate. Up and out there could be seen, thru the overlying retina, a grayish white mass somewhat uneven, the highest elevation being about 4 D. This mass extended from the temporal side of the disc, where it was very thin, outward beyond the equator. There was no independent vessel formation on the mass. The pupils were fairly large, but tension not above normal. The daily use of pilocarpin was advised with the hope of preventing hypertension and pain. The patient died three months later, with evidences of cerebral involvement and practically blind, but without the eyes becoming painful.

Case 4. Mrs. A. R. H., age 36. Seen November 7, 1921, complaining that something seems to come frequently before the right eye, so that print blurs and there is a constant tendency to rub something from the right eye. Vision O. U. = 20/30. Patient is slightly myopic. Examination of fundus, right eye, revealed a flat, discoid subretinal mass, located down and out from the macula. It was found 3 d.d. in size, and the upper inner edge reached to the lower border of the macula. It was quite white, with the center whiter than toward the periphery. No independent vessel formation was seen, and no measurable elevation of the retina. No evidence of inflammatory reaction to its presence. The visual field showed a partial scotoma up and in. A more extensive examination of the field was not attempted at this time, on account of the patient's poor physical condition. From these appearances, a diagnosis of carcinoma of the choroid was made, and then the history was obtained of two operations for mammary carcinoma. A few days later, an X-ray examination at the hospital showed extensive involvement of the left lung.

Remarks

In all four cases, either an autopsy, an X-ray or physical signs showed involvement of the lungs. With the lungs involved, it is easy to understand how cancer emboli can be taken up by the pulmonary vein, carried to the heart and thence thru the arteries to the meninges, choroid and other parts of the uveal tract. The lungs become involved either by direct extension, as from a mammary carcinoma, or thru the lymphatics and the pulmonary arteries. The presence of cancer emboli in the aterial circulation is well illustrated by the case of Ishihara, who described a primary mammary carcinoma with multiple carcinomatous emboli in the choroidal capillaries. There were three isolated tumor nodules in the choroid, and eleven distinct capillary emboli composed of carcinoma cells. In one of Dr. Weeks' cases, an eye with a choroidal tumor was removed and the growth found to be carcinomatous, with the primary source in the lungs only discovered at autopsy. A great many of the causes so thoroly tabulated by Suker and Grosvenor showed an involvement of lungs, when the rocords indicated a thoro general postmortem examination.

The author queries as to how often, if ever, a choroidal carcinoma occurs until after some involvement of the lungs. The discovery, therefore, of a whitish discoid subretinal tumor with moderate or little elevation of the retina, no independent vascular system, and no surrounding inflammatory reaction of the retina, should lead to a careful examination of the lungs, especially by the use of the X-ray.

In the author's first case, the tumor was diagnosed as a sarcoma. This has frequently been the case, and, if the pa-

tient is first seen after the onset of pain and hypertension, is to be expected. Hypertension is not the rule as in sarcoma, even when the eye is extensively involved. In his last three cases, including five years, hypertension was not present. How much the daily use of a miotic may have to do with preventing this painful complication can only be conjectured. In case 1, pain and hypertension were made to disappear by the use of cocain and miotics, sufficiently to prevent any necessity of enucleation. Pain and hypertension are the only complications which, if unrelieved by treatment, call for an enucleation of the eye, unless one is in doubt as to the differential diagnosis between metastatic carcinoma and sarcoma, and, in such a case, the removal should only be advised after an exhaustive physical and X-ray examination has proven negative as to carcinoma. It is possible that the more extensive pushing forward of the vitreous due to the greater projection of sarcomata tends to increase the liability to hypertension, while the flat carcinoma masses, even when extensive, do not encroach so much or so rapidly on the vitreous space and thus lessen the liability.

It is not possible to arouse as much interest in such an absolutely hopeless condition, but one should be on the lookout for these cases, particularly as they seem to be on the increase. Finding an eye, therefore, that presents a discoid white, or greyish white subretinal mass, located temporally not far from the macula, with the overlying retina only elevated 2 or 3 D, at the most, and no evidence of inflammatory reaction, or independent vascular system, particularly in women, be suspicious of metastatic carcinoma, remembering that such tumors rarely need enucleation.

In spite of an attempted differential diagnosis, cases will occur where an eye will be enucleated for sarcoma when the tumor is a metastatic carcinoma. In the author's first case, this would have occurred but for the evidences of an enlargement of the liver. It is doubtful if the reverse is ever found, viz., that a tumor, having been diagnosed as carcinoma, (after careful study), later turns out to have been sarcoma. This fact should be borne in mind when making a differential diagnosis. Therefore, when a tumor, having all the characteristics described above as being indicative of carcinoma, is so diagnosed and later the patient succumbs to what is very evidently a general carcinosis, especially if with evident lung and brain involvement, it may safely be considered that the correctness of a diagnosis of metastatic carcinoma of the choroid has been established, even if a microscopic study of the eye be not made or a general postmortem be conducted.

Metastatic Thyroid Tumor in the Orbit

Dr. Arnold Knapp, New York City, stated: Cohnheim was the first to recognize that goitre may cause metastases, and called them metastatic benign strumas. These metastases occur in the bones and in the lungs. Why they seem to select the bones is unsettled. A. Müller believes that the medulla of the bones furnishes a favorable site for their growth because of its retarded circulation. Thyroid gland cells after entering the circulation can remain viable, and in certain places proliferate and form tumors. Trauma plays here a definite role. The destructive power of these metastases is particularly evident in the bones. This destructive tendency, the formation of metastases, and recurrences, cause some authors to regard them as essentially malignant. The thyroid in some of these cases seemed perfectly normal. The tumor, may, of course, be overlooked in the thyroid gland.

Schmidt collected 49 cases of struma metastases. With metastasis, careful search reveals a carcinomatous part in the normal thyroid gland tissue. The site of these metastatic thyroid gland tumors is in various bones, particularly the cranial bones. 29 metastases occurred in the skull, principally in the frontal and parietal bones; in the vertabræ, 16; in the ribs and shoulders, 4; in the pelvis, 11; in the femur, 7; in the humerus, 6. The size varies from that of a fist to an egg. The age of the patient is between 30 and 60. It affects women more frequently than men. Trauma was elicited in 11. From the

standpoint of the histology of the tumor and the clinical course, the struma metastases were malignant in 39; uncertain in 5; possibly benign in 5.

CASE REPORT. E. R. B., age 66, Dec. 18, 1917: Has always been in good health until recently. Has complained of vertigo, and comes on account of discomfort in reading. Vision with glasses 20/20. Both eyes seem unduly prominent. The right upper lid droops, and the right eye is distinctly more prominent than the left. Exophthalmometer R. 32; L. 28. The motility of the right upward is restricted, particularly in abduction (superior rectus). Distinct vertical diplopia, increasing upward and to the right. This diplopia the patient has observed for one week. On palpating the right upper orbital margin, there is a resistance to be felt, especially in the region of the pulley, which consists of a soft mass within the upper margin of the orbit, occupying a round defect in the bone, where pulsation can be felt. The pulley is displaced. Optic nerve normal. Field normal. The blood count is normal; hemoglobin 90%. The Wassermann test is negative.

The Roentgen examination shows an area of increased radiability on the right side, indicating an area of softening. It involves the orbital plate of the frontal and extends above the superciliary ridge. It is about three-quarters of an inch in its widest diameter. It extends about one inch above the supraorbital ridge and along the orbital plate to the sphenoidal fissures. There seems to be no involvement of the frontal sinus, but there is a supraorbital extension of the ethmoid cells, which seems to be very near indeed to this area of softening. With the exception mentioned, we find no indication of disease of any of the accessory nasal sinuses. The skull is unusually thick, especially the outer table of the frontal bone.

Increasing doses of potassium iodid were prescribed for six weeks, without any change in the tumor. An operation was advised

Feb. 19th, '18. *Operation.* Curved incision below the eyebrow down to the periosteum, which was found continuous downward with a mass. Incision made thru the periosteum, and the attempt was made to elevate it. It was so firmly adherent to the underlying structure that this failed. The center of the mass seemed to be soft. The incision thru the periosteum was then enlarged, and immediately a dark hemorrhagic like mass, resembling granulation tissue, presented. The area was fully exposed, some of the periosteum removed, and the above described material was scooped out. The cavity was found in the bone extending back, upward and anteriorly and laterally. Profuse bleeding made it difficult to see, and one had to be guided by a sense of touch. After cleaning out all this soft material and some of the rough bone along the margins, a rather well defined cavity was exposed. The constant oozing was somewhat controlled by packing; it could then be seen that in two small places in the upper wall, the dura was exposed without being directly involved. The edges of the bony cavity were trimmed off, and the entire cavity packed with iodoform gauze. The external wound was left open. Length of operation one hour.

In brief, this seemed to be a tumor arising in the medulla of the bone, particularly in the anterior part of the frontal, where it forms the upper wall of the orbit. The cavity was filled with soft dark red material. This, in the lower part, was directly adherent to the periosteum. A striking feature was the extensive bleeding which seemed to be general. The bony walls of the cavity were smooth.

No reaction followed the operation. At the first dressing some of the packing was removed; considerable oozing. The specimen removed at operation was sent to Professor James Ewing who reported as follows:

"The tumor of the bone in the case of E. N. B. proves to be an adenoma of aberrant thyroid tissue. It is rather orderly in structure and not very malignant, altho in some spots the alveoli are still small and numerous. It reproduces thyroid structure to the smallest detail, many alveoli containing soft acidophil colloid surrounded by flat thyroid cells. Many small alveoli are exactly similar to the usual thyroid

adenoma. The stroma is scanty and not vascular.

"This tumor may arise from a portion of thyroid tissue originally present at that point in the embryo, or it may represent a metastasis of an adenoma in the thyroid. The thyroid gland should be examined for the presence of any small tumor at any point. I am inclined to prefer the former hypothesis, especially if there is no tumor found in the thyroid.

"The prognosis of these cases is not entirely favorable. Altho they have been called 'benign metastasing struma' they are not always benign. They recur locally, and the only other case in the skull which I have seen (Jeffries' case, in parietal bone) recurred locally and eventually produced metastases elsewhere. The thyroid was normal. Hence I recommend that radium be inserted in the wound, as the alveoli penetrate the bone spaces and are hard to reach by the knife. I know of no case treated by radium, but would expect this structure to respond well."

Feb. 24, all of the packing was removed and a radium tube 27 mc. protected by a lead plate introduced for four hours. The thyroid gland seems normal. March first, no reaction, slight secretion superficially; wound is allowed to close.

April first, 1918. The wound healed. A swelling remained at the upper margin of the orbit continuous with a bony mass externally just above the external canthus. Some exophthalmos remains, measuring R. 30, L. 28. Vision normal. Eyeground normal.

April 8th, 1919. Has lost about thirty pounds in weight. Complains of band over head and obscure abdominal symptoms.

July 1st, 1919: R. 31.5; L. 28. Diffuse swelling in orbit. Vision and eyeground normal.

Dec. 19, 1919: The orbital condition is unchanged. Diplopia to the right. Distinct soft pulsating mass in orbit. A swelling had been noted over right scapula for some months, and patient complained of neuralgia in right groin.

Dec. 29th, '19: The patient was referred to Professor James Ewing, who reported as follows:

"There is a tumor mass behind the eye, which causes distinct exophthalmos and protrusion of the supraorbital tissues of about 1 cm. The body of the right scapula is largely replaced by a tumor mass about 5 cm. in diameter, as shown by the X-ray. This tumor is of recent discovery and evidently growing actively. The left portion of the thyroid gland is the seat of a well circumscribed, rather firm tumor mass, about 4 cm. in diameter. There is pain in the use of the right thigh muscles, which was not investigated, but will receive attention later. The X-ray of the right lung shows several suspicious isolated nodules, which I suspect are tumor nodules, but which cannot be positively identified as such. Further X-ray photos of the lungs and bones will be taken. The patient has lost weight, is anemic and rather feeble, and is therefore distinctly cachectic. I feel that the prognosis is unfavorable, but that some help may come from X-ray and radium treatment.

"I would recommend that the tumor of the scapula be treated by X-ray, that the orbital growth be treated at first by a radium pack, and that the thyroid tumor be treated by the insertion of radium needles. This latter tumor is possibly the source of the others. The scapular growth was treated this afternoon. We propose to go after the others slowly, but steadily, avoiding undue disturbance of the patient."

The shoulder tumor was given eleven X-ray treatments from Dec. 29, 1919, to May 18, 1920. A radiograph on January 7th, 1920, showed a destructive process in the 8th rib posteriorly, and an area of bone destruction in pubis to right of symphysis. On Jan. 20th, 1920, a small area of destruction was found in the 6th rib posteriorly. The right groin was treated by X-ray four times from Jan. 6th, to May 4th, 1920. Radiograph on Jan. 7th, 1920, showed dense shadow above manubrium and to the left, of about the size of a small orange, indicating the presence of a calcified mass in the thyroid gland, pushing the trachea over to the right.

The orbit was treated with radium three times from Jan. 19th, 1921, to April 27th, 1921.

The patient, acording to Dr. R. W. Lowe, Ridgefield, Conn., then gradually lost weight, suffered from hallucinations and delusions, and was at times mildly maniacal. There was flatness over anterior and posterior chest (left); pleuritic pain, loss of motion over chest, dypsnea, slight cough. Lymphatic enlargement in neck (left side). Edema of lower extremities, increasing during the last two weeks. Died July 21st, 1921, apparently from cerebral hemorrhage.

In this patient, a tumor in the roof of the orbit was the first symptom of a malignant process. At operation destruction of a bone by a brownish, granulating tissue like mass was found present, unusually free from hemorrhage. The histology of the tumor showed it to be composed of thyroid gland tissues. No tumor could be detected in the thyroid on palpation. Symptoms of other metastases appeared one and one-half years later, and were confirmed by the X-ray examination in the scapula, in the 6th and 7th ribs, in the lungs and in the pubis, and at that time a distinct tumor was discovered in the thyroid gland, and the X-ray showed that it extended behind the sternum.

The location of these thyroid gland tumors in the walls of the orbit is unusual. In the literature, there is a report of a case by v. Eiselberg of a woman, 37 years old, who showed externally a bulging nodule in the substance of the parietal bone, projecting inward and adherent to the dura. Another nodule was situated in the right upper orbital wall, extending thru into the skull. The 6th rib, right, and the left humerus were also involved; struma present (adenomacarcinoma) autopsy report.

Jaboulay's patient, a female, 65 years old, presented a tumor in the superointernal angle of the left orbit, pulsating; old swelling of the thyroid gland. At operation the bone was found perforated, exposing the meninges.

Lymphosarcoma of Orbit With Intermittent Exophthalmos.

Dr. W. S. Franklin and Dr. F. C. Cordes, San Francisco, reported this case: Mrs. M. B., aged 33, was first seen in 1908. Her symptoms were those of a refractive error, namely hyperopia. The eyes were prominent without any apparent etiology. There was no thyroid disease and all other physical findings were negative.

August 1917 (eight years later), patient returned complaining of a slight drooping of the left upper lid. She was under treatment for an acquired lues. The eye findings were: Slight ptsosis of left upper lid. No apparent paralysis. Lid could be voluntarily elevated. Right globe somewhat more prominent than left. Movements of eyeball normal. Tension of left eye 32 mm., right 24 mm. No pupillary changes. Fundi negative. Perimeter fields, stereoscopic vision and color sense all normal.

Dr. Hewlett reported:

"The general physical examination in October, 1916, showed the presence of numerous crackling and musical rales in the left back and axilla. Wassermann reaction was + + +. Sputum negative for tubercle bacilli. On March 3, 1917, the white blood corpuscle count was 7,4000 with 83% of polymorphonuclear cells, 6% lymphocytes and 11% large mononuclears. From March, 1917, to September, 1917, the patient was receiving antiluetic treatment."

By October of the same year, the ptosis of the left eye had increased, with a beginning exophthalmos of 3 mm. The patient continued under most vigorous antiluetic treatment. November 21, 1917, the left eyeball became prominent. There was a marked swelling of the lids with chemosis. The examination for leucemia was negative.

December 20, 1917, the right eye was beginning to show exophthalmos, while the left eye was at its height and with its upward motion limited. Eight days later, the left was receding, and by January 15, 1918, both eyes were somewhat improved. January 20, the left eye was beginning to show recurrent exophthalmos, while the right continued receding, and on February 20, the left was at its acme for the second time, with the right normal. On March 1, 1918, the right was again markedly exophthalmic, with the left stationary, and by March 10, the left receded, leaving the right still somewhat swollen.

When the patient reported on April 5, 1918, the exophthalmos of the left eye was beginning to recur for the third time and the right was normal. On May 10, the left eye protruded markedly, and the right was again beginning to be swollen for the third time. As there was no improvement by July 6, 1918, the patient was put to bed, and by October 2, 1918, both eyes had receded, the therapy limited to hot compresses and rest in bed. The left fundus now showed a beginning optic neuritis.

A month later, a circumscribed nodular swelling was observed in the bulbar conjunctiva at the nasal side of the left eye. There was left sided optic neuritis. A small vesicle developed, which was punctured and showed a pure culture of staphylococci.

Right eye normal. Left eye, marked edema of both upper and lower lids, with chemotic conjunctiva bulging thru palpebral aperture. The globe protruded markedly, the exophthalmos being 10 mm. Entire conjunctiva injected and chemotic; at the inner canthus was a rounded nodule about the size of a pea, which appeared less edematous than the remainder of the swelling. The lower lid was overlapped by the growth, while the upper lid was enlarged, covering the superior third of the mass. The eye was amaurotic and showed a secondary atrophy of the nerve head. A small portion of the nodule was excised for microscopic examination.

The diagnosis was sarcoma of small round cell type, possibly lymphosarcoma. Later a diagnosis of lymphosarcoma was made and confirmed.

January 20, 1919, the left eye was enucleated. A circular incision was made just outside the limbus thru the conjunctiva, which was decidedly indurated. The ocular conjunctiva was dissected back, and the eyeball freed to the apex of the orbit. Muscles and nerve were then severed. The internal rectus muscle was obscured by a soft cellular tumor mass, which involved it thruout its length. Digital palpation of the orbit showed the tumor mass to extend to the apex of the orbit, impinging upon the superior orbital fissure. There was no apparent bony involvment at the superior nasal border of the orbit. Due to the extensiveness of the growth and the likelihood of involvment of the other eye, as indicated by the tumor, and the practical impossibility of radical excision, evisceration of the orbit was decided as contraindicated. All available parts of the tumor were removed and the wound packed.

Anteriorly, the tumor started from the edge of the cornea and was covered for some distance by conjunctival epithelium. It shows apparently little tendency to infiltrate the sclera, and in this region there was some edema of the preexisting tissues. The tumor as a whole was somewhat lobulated. While the main mass tended to grow away from the bulb, yet between the main mass and the bulb there was considerable tumor infiltration into the loose cellular tissue present. Towards the posterior end of the tumor, extensive infiltration of muscle was observed.

On January 25, 1919, the patient received 350 milligram hours of radium to the left orbit (screened by 1/2 mm. of silver and 1 mm. of brass) and an additional 300 milligram hours on February 3, 1919. Healing took place without signs of recurrence, altho there was considerable skin reaction from the radium.

Up to, and including April 26, 1921, the patient reported every few months for observation, and during that time there was no sign of recurrence on the left side, and the right eye was normal. The examination on April 26, 1921, showed V. R. E. 1.2 +. There was no exophthalmos, the exophthalmometer reading being 24 mm. The fundus was negative and the perimetric field for white and colors was normal. In July, 1921, we were informed that the patient had died, death being caused by an acute cardiac decompensation. There was an enlarged spleen, extending down to the pelvis, accompanied by a marked ascites. Several months previously, patient had complained of a chronic cough, and on one X-ray examination, a diagnosis of sarcoma of the lung was made. It was impossible to obtain a postmortem examination. Clinically, the entire picture was rather suspicious of a sarcomatosis.

The right eye was presumably also affected by lymphosarcoma, as its early

changes were identical with those of the left, with the exception of the appearance of the nodular mass. The case can justifiably be considered one of bilateral lymphosarcoma. Several unusual points are to be noted.

The bilateral occurrence of lymphosarcoma with marked exophthalmos is unusual. The occurrence of lymphosarcoma is rather infrequent. Retrogression followed by progression has not been noted. Because of the infrequency of lymphosarcoma of the orbit, we had the pathologic diagnosis confirmed by several independent pathologists. Bilateral exophthalmos due to retrobulbar conditions is comparatively rare. Syphilis had to be considered in this case, due to the triple plus Wassermann. Antiluetic treatment had no effect on our case.

We considered the possibility of lymphomata, but all examinations for pseudoleucemia were negative. Exophthalmos of the intermittent type due to circulatory changes in the orbit, such as telangiectases, cavernomas, angiomata and orbital varices, has been reported. In none of the cases was it due to an orbital tumor. Another interesting feature in our case was the continued observation, postoperatively, for a period of almost two and one-half years, with no signs of recurrence on the operated side or the unoperated eye. It has been observed a number of times, that removal of a tumor on one side, has been followed by improvement of the unoperated eye. The question arises as to the effect on the unoperated eye of the massive doses of radium, and whether or not the effect was sufficient to check the tumor's progress. We have been unable to find in the literature a case of bilateral lymphosarcoma with intermittent exophthalmos of the type described.

Chloroma.

Dr. Arthur J. Bedell, Albany, N. Y., said it seems fitting that we should devote a few minutes to a disease that is even yet subject to discussion, not only from its etiologic standpoint, but especially in relation to earlier diagnosis and subsequent treatment, of which we know so little.

Four cases were summarized, two of which had never been published.

Case 1. J. L., a boy eight years old, of foreign birth, entered the Albany Hospital December 3, 1906. The patient, semicomatose, was extremely emaciated, and his skin was yellowish. The right eye was proptosed 11 mm., with a growth in the upper part of the orbit. The lower orbital region was outlined by a freely movable mass, 12 mm. wide, which extended from the outer to the inner canthus. This mass was not attached to either skin or periosteum and its posterior margin was not palpable. There were two subconjunctival hemorrhages. Complete ophthalmoplegia externa. The cornea was clear. There was a marked optic neuritis with complete obliteration of disc outline, with areas of white exudate along the larger vessels. Vision equal to fingers at six feet.

The left eye was extremely prominent, extending 20 mm. beyond the orbital ridge, with complete ophthalmoplegia externa. The veins surrounding the lids were enormously distended and tortuous. Projecting beyond the superior orbital margin was a firm, freely movable, not adherent growth, which extended deeply into the orbit, and was palpable from the supraorbital foramen outward. The conjunctiva was markedly chemotic with numerous ecchymoses. The upper part of the cornea was clear, but the lower half showed a superficial necrosis and was covered with a dry exudate. Pupil 5.5 mm., not reacting to light or accommodation. There was a deep yellowish gray reflex from the fundus. No detail, no light perception.

Blood examination showed: red cells 1,410,000, white cells 79,600, hemoglobin 30%, and a differential count of 6,000 leucocytes showed: polynuclears 16.2%, large mononuclears 5.3%, large lymphocytes 15.3%, transitionals 0.8%, eosinophiles 0.7%, small lymphocytes 33%, neutrophile myelocytes 28.2%, eosinophile myelocytes 0.5%.

The patient was given chloroform, and a 3c.m. incision was made over the outer half of the superior orbital ridge. The entire orbit was found filled with a greenish mass of almost cartilaginous consistency, in part encapsulated, nowhere palpably adherent to the periosteum.

The patient's conditions grew progressively worse from the date of admission. Emaciation was extreme. Proptosis of both eyes more marked. On the right side the tumor mass increased 2 mm. in width, and the eyelid became darkly congested, with tortuous, prominent vessels. Vision almost totally lost. Pupil 6 mm., not reacting. No increase in the retinal changes. The lower half of the cornea of the left eye was infiltrated and the outer layers eroded. No fundus visible; no decrease in the chemosis; veins more enlarged. No drainage from the wound. The glands of the neck were greatly enlarged; on the left side being as large as pigeon eggs. Veins of the neck showed no signs of thrombosis.

On December 10th, the child had a convulsion, was removed from the hospital and died that day. Autopsy was not permitted.

Case 2. Mrs. N. G., aged 18, married, a Russian by birth, was admitted to the Albany Hospital April 7, 1909. One month prior to admission, she first noticed many small, hard, insensitive lumps in each breast, which she believed had not increased in size. March 8, 1909, she had "pink eye," from which she seemingly recovered; on March 27th, her eyes began to bulge, causing pain and attacks of blindness.

April 8th, the right eye proptosed 20 mm., immobile. The upper lid showed great dilatation of the blood vessels, and altho it covered one-third of the cornea, it could be retracted, while the lower lid was covered with chemotic conjunctiva. A definite tumor mass, 20 by 12 by 8 mm., was outlined over the lacrimal gland, entirely in the lid, with no deep attachment. The superior two-thirds of the cornea was clear, but the lower third showed a dense interstitial and superficial haze. Pupil 1.5 mm. Vision, fingers at 3 feet.

Left eye proptosed 18 mm.; small nodule in the upper lid at the outer side; cornea hazy below, pupil 4.5 mm., stationary. Vision, fingers at 3 feet. A large mass of grayish appearance pressed the retina forward, and except for an occasional vessel, obscured fundus detail.

Blood examination made by Dr. James F. Rooney, April 8th, showed: reds 3,150,000, whites 36,500, hemoglobin 55.0%.

Four days later, the right eye bulged forward 25 mm., with intense engorgement of the veins of the lids and temporal region. The tumor was now 25 x 11.5 mm., axis 60 degrees, not adherent to the skin or periosteum, altho extending deeply into the orbit. The outer part of the lower lid was filled by an oval, unattached growth, 18 by 9 mm., x 11.5 mm., axis 60 degrees, not adherent; eyeball, including the entire cornea, was exposed. The conjunctiva was chemotic, with many small ecchymoses, and a small hypopyon in the anterior chamber. Pupil 2 mm., stationary, tension normal; extremely limited motion of the globe; vision light perception.

Left eye proptosed 22 mm., with many irregular nodular masses in the upper, outer two-thirds of the orbit, close to the superior wall, but not adherent to it. The upper half of the cornea was covered by a vein-filled upper lid, the lower half was rough and infiltrated. The bulbar conjunctiva was decidedly congested and the eyeball stationary. The interior of the eye was as before. Pupil 4.5 mm.; faint reaction to light, tension normal.

The disease was diagnosed chloroma by the examination of breast tissue. This was done before the patient died, on April 16, after a premature delivery of a dead child. As in many cases, persistent, uncontrollable nasal hemorrhage was present for several days before death.

The following is the autopsy report by Dr. Wolbach, held April 16, 1909:

Autopsy limited to chest and abdomen, so that the orbits were not investigated.

Anatomic Diagnosis. Chloroma with metastases to sternum, heart, bronchial nodes, kidney, pancreas and lymph nodes.

Case 3. B. R., age five years, entered the Albany Hospital April 23, 1913, and was discharged May 16, 1913. The dominant symptom was a firm, ovoid growth occupying the upper one-half of the right orbit, producing the effect, as shown in the illustration, of a mass anterior to the eyeball. The skin was freely movable over it but the tumor extended deeply into the orbit. The right eye was movable in all directions, without fundus lesion. The left eye and

orbit were uninvolved. The patient had a peculiar sallow appearance. He had several slight hemorrhages from nose.

The blood count showed: white blood cells 7,700, red blood cells, 1,930,000, hemoglobin 55%.

The temperature ranged from 99° to 102°. Wassermann reaction was negative. Before the child was taken home, where he died June 5, 1913, the right eye became very prominent with practically no motion. Definite masses, similar to that in the upper lid, also appeared in the lower, filling the orbit. A firm lobulated tumor, deep in the left orbit, produced marked exophthalmos. The temporal region became infiltrated. The hearing was greatly reduced. There was no marked glandular enlargement. The patient died with meningitic symptoms.

CASE 4. J. N., a girl seven years old, of foreign extraction, entered school a year ago and seemed to be normal in every way. After being in school a few weeks, she began to complain of headache and would cry for hours. On July 4, 1921, the child's right arm was severely burned, and she was sick for three weeks. On October 27, the right eye bulged forward 11 mm., with limitation of motion vertically but not horizontally. There were several large, rounded masses, freely movable beneath the skin but extending into the orbit, and seemingly adherent to the superior orbital ridge. There were also masses in the lower portion of the orbit, with the same characteristics. The pupil was 6 mm., stationary, media clear with an intense neuroretinitis, many areas of whitish exudate and several flame shaped hemorrhages. The left eye protruded 8 mm., with the same type of masses extending deep in the orbit. There was definite swelling of the optic nerve with retinal exudate. In both temporal regions there was a firm swelling, and the patient was totally deaf.

I sent her to the Albany Hospital with a diagnosis of chloroma. This was verified by the blood examination which showed:

Red blood cells 3,100,000, white 20,800, hemoglobin 67%.

Temperature, which on admission was 100°, dropped to 98° the next morning, but then rose above 103°. The parents took the child from the hospital when they were told that the outcome would be fatal. The child died at home November 9, 1921, and it was impossible to get an autopsy.

In the complete review of the literature, we find that ninety cases have been reported, twenty-five females, five sex not stated and the remainder males. The age varied from one year and nine months to fifty-five years; by far the greater number being in children and young adults. The duration of the disease was so uncertain, that even in the statement that many died within one month, some even within four days after the primary visit, helps little in the diagnosis. The greatest number of cases were only properly understood at autopsy.

The reported white counts varied from 6,200 to 519,600. In only six cases, however, was it 100,000 or more. The commonest count is less than 40,000, and as will be noted in our own cases, one count was 6,200. On the other hand, the differential count gave information of the greatest value, for in all cases we find a marked decrease in the polymorphonuclears with a considerable increase of the myelocytes.

The diagnosis of this condition can be made early. Every case of exophthalmos in a child should have an immediate complete blood examination, for, as has been proven by many and corroborated by our cases, the first symptom is in the blood change.

The treatment has ranged from benzol, to X-ray, to radium. The lack of curing power, when late at least, is evidenced by the fatal outcome of all cases.

Chloroma, a disease of the blood making organs, lends itself to early diagnosis by its characteristic blood picture. The common eye symptoms are lid and orbital tumors, exophthalmos, subconconjunctival hemorrhages, retinal hemorrhages and exudate, neuroretinitis and blindness; altho frequently unilateral, most often the changes become bilateral; and finally, investigation will doubtless prove an infection the origin of the disease, and such infection will be diagnosed and cured.

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EXERCISES FOR HETEROPHORIA.

The ocular muscles are present in the oldest and lowest forms of vertebrates. In some of the primitive fishes, they have forms, development and individual functions strikingly similar to those of the ocular muscles in man. But binocular vision, as developed in man, is wholly absent until we reach the order of primates, to which man belongs. The ability to fix the same point with both eyes is quite absent in most mammals. Nothing like the development of the macular and foveal region in the retina is found below the primates. The lower mammals have neither the histologic structure, nor the functional control of their eye movements, that furnish a basis for binocular vision.

Heterophoria is a disorder of binocular vision. In a man with one eye, it cannot exist. It is not connected with the presence or development of individual muscles; but with the coordination of their actions; and specifically with those coordinations which have to do with the fixation of both eyes upon the same point. Such coordination of the movements of the two eyes is impossible in comitant squint. In heterophoria it may be quite accurate, but it is not easily maintained. Perfect and easy coordination is not dependent on the size or strength of the muscles to be controlled, but on the perfection of the controlling mechanism in the central nervous system. Exercises for correction and relief of heterophoria are not primarily "muscle exercises," but are exercises in nerve control.

A common conception of the results of "exercise" is that of the muscles of the blacksmith's arm. The weighted contraction of certain muscles produces great development in bulk and power. The ability to shorten the muscle against resistance is increased. But the hypertrophied muscle is not necessarily any shorter than the undeveloped muscle when at rest. The "tonus" of a muscle, which determines its length when at rest—not contracted by voluntary effort—seems to be kept up and modified by nerve impulses that come thru the central nervous system, but probably start from sensory impressions and afferent impulses in general; and it is not dependent on the bulk of the muscle. The balance between opposing ocular muscles does not depend on their size, or power of

overcoming resistance; but on the coordination, the proportionate distribution of these nerve impulses among the opposing muscle. This fact must be appreciated to avoid a grossly mechanical conception of nerve-muscle actions, which would make us seek the correction of heterophoria by crude mechanical changes in the muscles.

We have absolutely no evidence that any form of "exercise" produces, even in slight degree, changes in the ocular muscles, comparable with those in the blacksmith's arm; or that such changes would bring about the change in the relative length of the opposing ocular muscles that would give orthophoria. Indeed, contracture, shortening of a muscle, often occurs as the muscle undergoes atrophy; and such contracture would turn the eye in the direction of the atrophic muscle. The essential change that brings about the erect carriage of the soldier is the change in nerve impulses going to the muscles of his trunk; at first it is the change in voluntary impulses, and later the change in those that produce muscle tonus. This may not be attended by any increase in the bulk of his muscles, altho generally there is such increase. The carriage of a stonemason or a foundryman may be much improved, without increase in the bulk of any of his muscles.

There is a striking absence of evidence of hypertrophy in the contracted muscles of squint, even squint of high degree that has existed many years. The muscle is shortened but its total bulk or weight is not increased. There are no facts showing, directly or by analogy, that increase in the bulk of an internal rectus muscle would correct exophoria; altho the habit of indefinite confused thinking on the subject may have convinced us that such should be the case. The ocular muscles are unfavorably situated for producing hypertrophy by exercise. Increased resistance to the contraction of a rectus muscle can only be brought about by increased action of its muscular opponents; or by extending the movement it produces to its limits. The movements of the eye are checked, not by resistance gradually increasing and furnishing a stimulus to greater contraction of the muscles exercised; but by nonextensible bands, the check ligaments, which set a definite limit to the excursion of the eye in any direction. The limits thus set cannot be altered by any form of exercise. By attaching weights to the insertions of the muscles and executing the usual movements of the eye with them, as has been done to test the power of individual muscles, we might develop a true hypertrophy and increase of power in an individual muscle. But it is doubtful if this would alter the muscle tonus, or change the rest position of the eye.

Exercise of convergence, particularly the fixing of a pencil point brought slowly to and within the near point of convergence, or turning the eyes strongly laterally; or "weighting" the divergence; by prisms base in, when the eyes are fixed on a near object, and then slowly increasing its distance may tend to increase the power of the muscles thus exercised. But prisms placed in succession before the eyes, to be "overcome," simply excite changes in the innervation of the eye muscles to avoid diplopia. This may in time change the habitual tonus of these muscles and their state of balance when at rest.

It is probable that turning the eye in a certain direction and contracting all the ocular muscles at once, as one does with the muscles of the upper extremity when arm and hand are held rigid in a certain position, may influence the balance of the ocular muscles. Exercises Nos. 6 and 11 of Walter Camp's "daily dozen," in which the eyes are directed toward an extreme position, while many muscles are strongly contracted in a "stretching" movement, are certainly of value in heterophoria. But the most valuable exercises for heterophoria are such games as tennis, polo, hand ball and basket-ball, in which accurate fixations of the eyes are closely coordinated with active movements of the whole body.

In regard to exercises for heterophoria, there is need for better understanding of certain points in the physi-

ology of "hypertrophy" and "tonus" of muscles, and the relations of muscle power and coordination. There should be more definite thinking about just what is to be accomplished for the relief of heterophoria. There should be careful observations as to the changes of muscle balance, brought about by changes of innervation produced by the wearing of correcting lenses, or lenses that increase or relieve accommodation. The effect of exercising a "loaded" rectus muscle would be an interesting addition to our knowledge. Finally, the effects of broader exercises of muscles and nervous system on heterophoria and its symptoms, should be more generally in mind. The dominant thought of modern medicine is, that the body must be considered as a whole, all its parts interrelated and interacting; and this is most evidently true of muscle exercises, and coordinations thru the nervous system.

E. J.

SCLEROCORNEAL TREPHINING IN MADRAS.

It was in the Government Ophthalmic Hospital at Madras, India, that Elliot first worked out, applied and reported trephining at the sclerocorneal junction for glaucoma. This was more than 12 years ago. Undoubtedly his patients who were operated on in this way, about that time, are seen or heard from occasionally in that service; so that the longest experiences of the late results of such operations are there obtainable.

Altho Col. Elliot's name is still honored at Madras in the Elliot School of Ophthalmology, his reputation has been based largely on the value of this operation. Another generation of operators has succeeded him, with their own points of view and their own ambitions to leave their impress upon ophthalmic practice. It is therefore of interest to learn from the last Report of the Government Ophthalmic Hospital just what importance is attached to this operation in the clinic in which it originated. In this report for 1921 we read:

"Elliot's operation is still almost invariably performed for glaucoma. One exception is constant, namely acute secondary glaucoma due to swelling of the cataractous lens in which complete broad peripheral iridectomy is done. This condition, which is fairly common, is always dealt with in the acute state, and the results are very good. We prefer to give a general anesthetic as the eye is excessively tender and the operation is possibly the most difficult with which we ordinarily have to deal. It will be observed that not only is trephining done for glaucoma, primary and secondary, but also for staphyloma; in which it is usually combined with radical cauterization or conjunctival flap treatment of the protuberant scar tissue. It is also adopted in many cases of extensive leucoma adherens following ulcus serpens, in order to protect the eye against subsequent glaucoma due to narrowing of the angle. Such cases are done as soon after the ulcer is healed as is reasonable from the points of view of a clean conjunctival sac and a stationary leucoma. If possible, the trephining in such cases is combined with optical iridectomy. If there is any clear peripheral cornea in the inferior nasal quadrant, this site is selected. A certain number of cases were trephined after cataract operation, either because of increased tension, or because we feared this sequel on account of the diminution in the total available angle, owing to involvement of the pillars of the coloboma or other impactions in the section. When the pillars of the coloboma become adherent at their bases and capsule is impacted in the upper part of the section, it means that about 1/6 to 1/3 of available angle is thrown out of action. It is not desirable to lose sight of such patients. We prefer to protect such eyes by a prophylactic trephining.

Encouraged by last year's successes in trephining eyes which had been blind for over three months, we have extended the period which limits our operative interference. We now trephine eyes which have been blind for

six months and under. So far, we are not aware of any case in which an eye blind for six months regains any perception of light after operation. Last year's cases constitute our justification for the procedure now adopted."

The total of trephinings done last year seems to have been 309. Of these 239 were for glaucoma, 41 for staphyloma, 12 after cataract extraction, retinitis pigmentosa 8, detached retina 4, recent leucoma 2, and spontaneous dislocation of the lens 1, while twice the trephining was repeated. These figures regarding an operation in constant use for 12 years seem to indicate, that under the conditions of this clinic and for the patients that apply to it, sclerocorneal trephining is about as well established as any operation in ophthalmic surgery.

E. J.

BOOK NOTICES.

Report of the Government Ophthalmic Hospital, Madras for 1921, Major R. E. Wright, I. M. S. Quarto, 38 pages. One plate with 3 illustrations, Madras Government Press, 1922.

Of this large pamphlet, 4 pages are given to administration report and statistics; and 34 to the "professional report." The latter is chiefly taken up with scientific matter of the highest interest to the ophthalmologist. Much of this is so condensed, that the amount presented is quite out of proportion to the size of the publication. Each page is equivalent to about two or three pages of the ordinary text-book. This series of reports should go into every complete library of works on ophthalmology. The illustrations give parts of the temperature chart and sketches of the fundus, in a case of subhyaloid hemorrhage in the macular region occurring with malaria.

The reports of former years seem to have been prepared by Lt. Col. Kirkpatrick, the Superintendent, now absent on leave, and Maj. Wright, the Acting Superintendent. The present issue contains reports upon special conditions and cases by eight members of the staff, with comments by Maj. Wright. The topics thus discussed include the spontaneous dislocation or rupture of Morgagnian cataract, keratomalacia, spontaneous dislocation of small lenses with glaucoma, malarial amblyopia, encephalitis lethargica, neuritis from sinus disease, Mooren's ulcer, fundus changes in polycythemia, serum treatment of trachoma, leprous iritis, and a dozen others. These clinical observations, briefly recorded, are of such practical value, that we shall quote from them in these pages in subsequent issues, since they are not elsewhere accessible to western ophthalmologists.

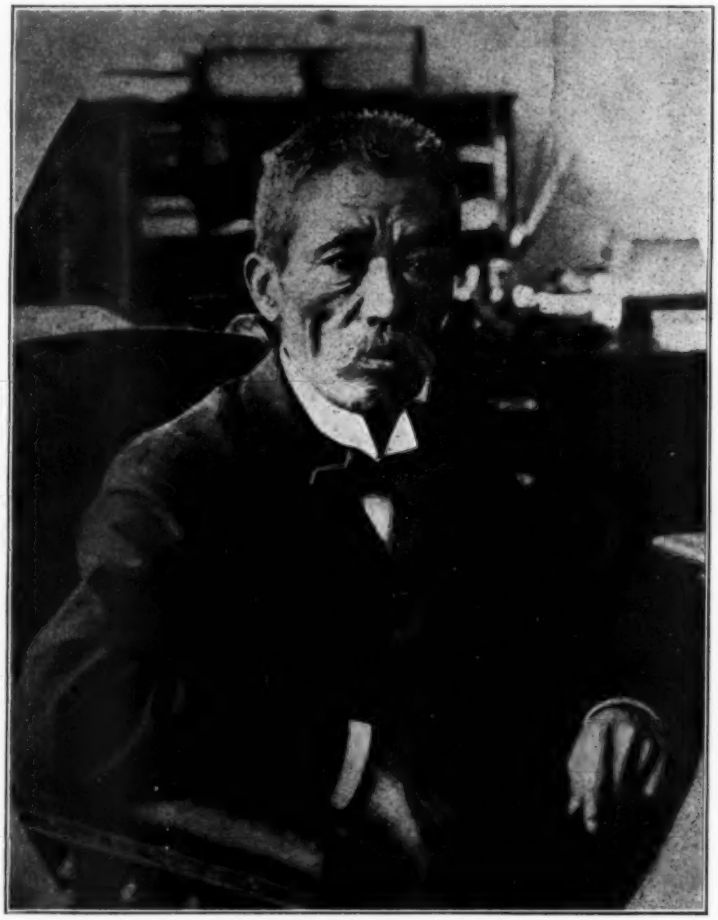
In connection with the Elliot School of Ophthalmology, attention is called to journals and transactions lacking to complete their files of ophthalmic journals, and to a short list of duplicates available for exchange. The school and hospital together constitute a rather important center for ophthalmic training. In addition to 178 medical students given instruction in this branch during the year, 20 Civil Assistant Surgeons and 30 Sub-Assistant Surgeons took a postgraduate course in ophthalmology. The other postgraduate students numbered 20, of whom 2 were from overseas.

The number of out-patients treated in the Madras Ophthalmic Hospital was 19,828, and of in-patients, 4,023. The number of operations performed was 4,356, of which 1,508 were for cataract. It is interesting to note that among these were 56 by the Barraquer method; 8 with loss of vitreous, 3 failures, and 6 others giving vision of 2/60 or less. Of 8 expression operations done after the "Smith-Indian" method, 7 ranked as successes and 1 with vision between 6/36 and 2/60. Among the other common operations were 284 sclerocorneal trephinings, of which mention is made elsewhere; and 224 excisions of the lacrimal sac.

This series of reports shows from year to year a growth and development that it is to be hoped will continue. Already it is one of special value to the ophthalmologist seeking to meet the difficulties of daily practice. E. J.

BIOGRAPHIC NOTICES.

PROFESSOR IKUJIRO ASAYAMA, a "Samurai" or knight of the Zeze clan in the province of Omi, was born at Yedo (now Tokyo) in the year 1861. He graduated from the College of Medicine of the Tokyo Imperial University in 1884. In the same year, he was appointed an instructor in the Kyoto Medical School, and later was made head of the department of ophthalmology. In 1898, when the College of Medicine of the Kyoto Imperial University was created, Doctor Asayama was sent to Europe to study, by the Department of Education of the Imperial Government, with the purpose of preparing him to take charge of the department of ophthalmology upon his return.



Prof. Ikujiro Asayama, 1861-1915.

He spent four years in special study of ophthalmology at the Universities of Berlin, Würzburg, Heidelberg and Vienna. At Heidelberg, under Professor Leber, he took up the subject of the absorption of the aqueous from the anterior chamber. At Vienna he gave his time to the study of sympathetic ophthalmia under Professor Fuchs. While still abroad, in 1901, Doctor Asayama was appointed assistant professor of ophthalmology and head of the department in the College of Medicine of the Kyoto Imperial University.

Upon his return to Japan in 1902, he was promoted to a full professorship, a position which he held until his death. The following year he presented his thesis and received the degree of M.D.

During the Russo-Japanese war, Doctor Asayama was in charge of the eye unit at the Osaka reserve hospital. For his services to the country at this time, the Fifth Order of Merit and the Order of the Sacred Treasure were conferred upon him. Still more honors were later bestowed upon him. In 1912 he was raised to the Fifth Class rank, and was granted the Fourth Order of Merit. Three years later, when the doctor was on his death bed, His Majesty the Emperor, by special grace, promoted him to the Fourth Class rank. This distinguished physician passed away at Kyoto on the 9th of November, 1915, at the age of 54.

Two strongest features of his character were faithfulness and a high sense of duty. He was upright, sincere, eager to learn, and uncompromising in his search for truth. He did not accept new theories readily; but, once accepted, he followed them unswervingly, and could not be led to change his mind. He prized truth and abhorred vanity. His method of teaching was not so much to instil learning into the minds of his pupils, but rather to draw the students out and encourage them to discover truth for themselves—a distinct contrast to the spoon-fed methods usually employed in his country. Thus the students in his courses, being pressed with question after question, as the professor energetically pursued the subject from point to point, often were baffled for a time; but gradually they were stimulated to increased effort, and finally an eager spirit of inquiry was aroused, which produced the desired results.

Professor Asayama was a prodigious worker, but realized the necessity for an occasional complete relaxation. His favorite pastimes were fishing and travel, especially in his own country.

His scientific research was almost entirely confined to the pathologic anatomy of the eye, in which he was considered the most eminent authority in Japanese scientific circles. It was he, moreover, who first described the socalled retinitis centralis, which created so much discussion at the time of its publication. Doctor Asayama's paper on this subject was published in Volume II, No. 2, of the Nippon Ganka Gakkai Zasshi in the year 1898, and is still considered one of the best treatises on that disease.

The doctor was one of the promoters of the Nippon Ganka Gakkai Zasshi, now the leading ophthalmologic journal in Japan, which was for a time the sole organ of the Nippon Ganka Gakkai, which is the name for the Japan Ophthalmological Society. After provisional rules had been drawn up, he had copies distributed among the projectors, and the journal was finally started in 1897. The title was later changed to the present one, but the object has continued the same thruout and steady progress has been made, thanks in great measure to Doctor Asayama's efforts. Not only did he attend the general meetings of the society regularly, but he also published most of his articles on research work in its journal.

Professor Asayama was a man of great administrative ability. The present building of the Ophthalmological Department of the Kyoto Imperial University, which was completed in 1910, was planned by him. It is said that, in point of completeness, its equipment is unequalled in any other country.

The writer, in a tour of hospitals and medical schools in the summer of 1920, visited the medical college and hospital of the Kyoto Imperial University, and found the space for clinical and research work and the equipment in the department of ophthalmology superior to anything else he saw in all the rest of Japan. At that time, he met the late Doctor Asayama's able successor, Professor Ichikawa, and had ample opportunity to see for himself the results of the splendid work that had been performed by Doctor Asayama, as well as the magnificent way in which the work is now being carried on by the present head of the department.

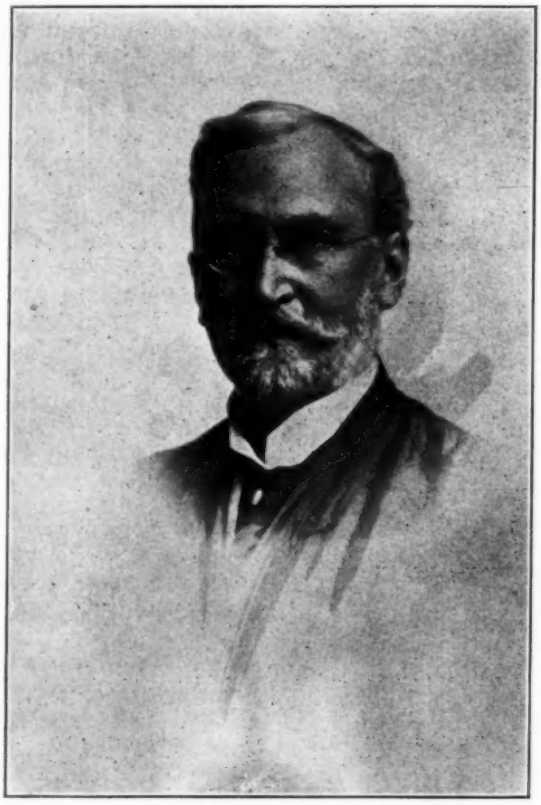
In connection with his extensive research, Professor Asayama wrote many scientific papers, among which the following are probably the best known:

1. An Exhaustive Histologic Study of a Case of Ophthalmia Sympathetica.
2. On the Anatomy of the Ligamentum Pectinatum.
3. On the Absorption of Aqueous from the Anterior Chamber.

4. On the Pathology of Keratitis Punctata Superficialis.
5. On Ulcus Rodens.
6. On Retinitis Centralis.

One of the greatest contributions that Professor Asayama has made to ophtholmology in Japan has been the fact that he gathered around him a group of earnest students, who quickly caught the spirit of their great teacher, and who are now counted among the leaders that are advancing ophthalmology in Japan by scientific methods and research. In point of history, he came just a little later than Professor Komoto of Tokyo, and in a true sense shared with him in establishing the specialty of ophthalmology on such a high plane in Japan. No greater tribute can be paid to him than to state that among his former students may now be counted many Professors or Associate Professors of Ophthalmology in Japanese medical schools, of whom should be mentioned Professor Ichikawa of Kyoto Imperial University; Professor B. Koyanagi of Tohoku Imperial University; Professor S. Suganuma of Keio University Medical College, Tokyo, and Professor Y. Matsuoka of Nagasaki Medical College.

HARVEY J. HOWARD.



George Milbry Gould, 1848-1922.

GEORGE MILBRY GOULD, Atlantic City, N. J., died at his home, after an illness of three hours, from heart disease, August 8th, aged 74 years. Dr. Gould was born in Auburn, Me., Nov. 8th, 1848, the son of George T. Gould and Eliza A. G. He served in the Civil War, 63rd Ohio Vols. as a drummer boy in 1861-2, and as a volunteer in 1864-5. In 1873 he received his A. B. degree from the Ohio Wesleyan University and the A. M. in 1892. He attended the Harvard Divinity School in 1873, and served as a Minister until he took up the study of medicine.

He became an M. D. at Jefferson Medical College in 1888, and began practice of the specialty of ophthalmology in the same year. Dr. Gould was Ophthalmologist at the Philadelphia Almshouse in 1892-4. He was editor of the Medical News 1891-1895; Philadelphia Medical Journal 1898-1900 and American Medicine 1901. Dr. Gould was a Fellow of the College of Physicians of Philadelphia; member of American Ophthalmological Society and President of the American Academy of Medicine in 1895. He was a speaker of the Congress of Arts and Sciences at the St. Louis Exposition in 1904. He received the first Doyne Medal of the Ophthalmological Congress at Oxford England.

Dr. Gould was internationally known as an author of medical and ophthalmologic works. He came to Atlantic City more than ten years ago in search of health, and as a haven of rest from more than twenty-five years of literary work. Among his works "Anomalies and Curiosities of Medicine," 1901; "Compend of Eye Diseases," (in collaboration, 1886); "Diseases of the Eye," 1879; "American Year Book of Medicine and Surgery," 1896-03.

His illustrated Dictionary of Medicine, Biology and Allied Sciences first appeared in 1894. Upon it were based the Students' Medical Dictionary, the Practitioners' Medical Dictionary, the Dictionary of New Medical terms and the Pocket Pronouncing Medical Lexicon. In ten years after the appearance of the first of these, 166,000 copies of his dictionaries had been sold. Of books addressed to readers outside the medical profession, he published "Boderland Studies," 1897; "Biographic Clinics," 6 vols., 1904-08; "Concerning Lafcadio Hearn," 1908; "The Infinite Presence," 1910; and "The Life and Letters of E. C. Stedman," (in collaboration) 1910. He was a man of varied interests with a broad point of view and a thoro writer.

FREDERICK FRISCH.

ABSTRACTS

Pereyra. Retinal Hemorrhages from Malaria. Arch. di Ott., 1922, v. 29, p. 49-78.

In a review of the literature on this subject, the author mentions various ocular changes which malaria can produce in the eye. Among these are three types of corneal affection, dendritic, herpetic and interstitial keratitis, all of which may be due to malaria. Conjunctivitis, iritis and choroiditis may also occur in cases of malaria. The nerve may also show a number of changes, the most common of which are: 1, simple hyperemia; 2, papillitis; 3, retrobulbar neuritis; 4, acute endocular neuritis; 5, neuroretinitis; 6, atrophy, which in all cases is secondary to an inflammatory process.

The retina may show pigmented changes, the result of chorio retinitis and endarteritis of small vessels, and may even be ruptured by pathologic adhesions between the retina and vitreous. The author is especially interested in retinal hemorrhages, on account of having seen a number of cases and having opportunity to examine the eyes of one at postmortem. He examined three cases in which the retinal hemorrhages were in a fresh stage, and was able to follow them during absorption. One case died of pneumonia during observation. Two more cases were seen some time after the active trouble had subsided.

The three active cases showed lesions quite similar in type. Each had rather large hemorrhages involving the upper half of the macular region, but not including the fovea, so that central vision was fairly well maintained. These were all of the superficial type, apparently pushing forward the internal limit of the membrane of the retina slightly, and being concave above and convex below. In several eyes there were two or more of these rather large hemorrhages. In all cases they absorbed rather completely altho somewhat slowly, and good central vision was regained in all but the case which died. Yellowish spots, with a slight amount of pigment around the border, remained from the hemorrhages that had absorbed. In the two old cases, areas of depigmentation marked the site of former

hemorrhages. The two cases of estivoautumnal fever were more severe than the case of tertian. The case which came to postmortem was especially interesting, since it presented the ordinary type of malaria, all previous cases having been patients dying of malarial cachexia or severe anemia. Sections showed that the hemorrhage was confined to the internal layers of the retina and chiefly to the nerve fibers. The internal limiting membrane of the retina was raised slightly around the large hemorrhage, and in one place near the fovea, the blood had produced a fissure thru the thickness of the retina. Pigment granules, probably from broken down parasites, were present, free and in the leucocytes. No plasmodia were found, probably because of fixation in formalin.

S. R. G.

Vogt, A. Ophthalmoscopic Examinations of Macula Lutea in Red Free Light. Klin. M. f. Augenh. v. 66, 1921, p. 321.

The red free light of ophthalmoscopy shows the macula in its yellow color. The dark fundus ordinarily appears light grey, instead of red, and can in a certain degree be placed in parallel with the fundus in red free light, for the retinal image is naturally less veiled by the choroidal light than in the eyes of common pigmentation. Hence it is well known that particulars of the retina, particularly reflexes, are especially clear in dark fundi. The red free light gives especially favorable conditions. The macula lutea is only the central yellow part of the fovea, including the "foveolar reflex," while the fovea is the whole pit of about the size of the optic disc. The yellow color of the macula in red free light is of great practical value, as it allows the finding of this most important area of the retina in cases in which this is not possible in ordinary ophthalmoscopic light.

Vogt describes very different conditions with the disappearance of the yellow color, including 3 albinos and a girl with albinotic fundus, in which it was undoubtedly congenital. It was acquired in retinitis, detachment of the retina, and blindness from traumatic interruption of the blood supply.

An affection of the yellow field is the honeycombed macula, apparently cystoid degeneration. Vogt found it in several cases of retinitis pigmentosa. In other cases, it could be proven that the cyst formation led to a hole of the macula by rupture of a cyst. Cystic remnants in the bottom of the hole are a differential diagnostic sign of the hole formation from the posttraumatic. If in an otherwise healthy eye the yellow zone is absent, it is pathologic, as shown in 2 cases with impaired central vision.

C. Z.

Babonneix, L. and **Hallez, G. L. Infantile Cerebral Hemiplegia and Hemianopsia.** Gaz. des Hôp. 1922, v. 95, p. 997.

This condition was first observed by Freud in 1889, and then by Vogt, but cases are rare. The patient, a boy of 2 years, suffered during his first months with repeated vomiting and diarrhea. At the age of six months, he had convulsions located in the face, with nystagmus, lasting some seconds. These have reappeared about every 3 months, at first tonic, then clonic. At the age of 7 months, generalized convulsions, with high fever and paralysis, chiefly of the left side. Ophthalmic examination by Dupuy-Dutemps showed, at the present time, a constant deviation of the eyes to the right, the pupil never passing the mediopalpebral line to the left. But there is no paralysis of movement toward the left, as the eyes turn toward the left during the process of examination. While a left hemianopsia cannot be proven, it probably exists, since the child turns neither head nor eyes to the left when the light comes from that side. This probably explains the turning of the eyes to the right.

C. L.

Purtscher, A. Treatment of Prolapse of the Iris. Wien. med. Woch. 1921. No. 24, p. 1078.

In order to obtain a solid and flat scar in exposed prolapse of the iris, Purtscher applies several times daily a 2% solution of nitrat of silver, neutralizing it with sodium chlorid. The silver solution can be gradually increased to 5%. In suitable new cases the prolapse is excised.

H. A.

NEWS ITEMS

DEATHS.

Dr. Julius G. Ehrhardt, St. Louis, Mo., died September 3rd, aged 75.

Dr. Frank Fisher, Philadelphia, Pa., died September 5th, aged 68.

Dr. Edward H. E. Stack, of Bristol, England, died in London, August 3rd, aged 55.

Dr. Theron Yeomans Sutphen, Newark, N. J., died in Maine, August 24th, aged 72.

PERSONALS.

Dr. D. G. Golding, of Fresno, has located in San Francisco.

Dr. Louis S. Dixon of Boston has retired from active practice.

Dr. Hans Barkan has returned to San Francisco after spending nine months in the European clinics.

Dr. Bárány, formerly of Vienna, and winner of the Nobel prize, will give courses in Denver and Los Angeles in November.

Dr. Edward M. Talbot, late Lt.-Colonel Medical Corps, United States Army, has located in San Francisco.

Dr. F. L. Stauffer has returned to practice in Salt Lake City after a year of postgraduate work in Philadelphia and Boston.

Dr. A. E. Gill of Denver has gone to Salt Lake City to assist Dr. C. A. Broaddus in the government's work in eye, ear, nose and throat.

Dr. J. H. Farrell, of Honolulu, is spending several months in Vienna doing some investigation work on the eye.

Miss Ida C. Mann, of London, has been appointed to the Henry George Plummer Fellowship in Pathology.

Mr. A. L. Whitehead has been elected president of the Section on Ophthalmology of the Royal College of Medicine, 1922–1923.

Dr. Charles H. Hoffhine has recently been appointed a member of the consulting staff of the Bureau of Juvenile Research of Ohio.

Dr. W. Uhthoff, professor of ophthalmology in the University of Breslau, has retired, and the chair has been offered to Dr. A. Bielschowsky.

Drs. Ray A. Irvine, F. H. Raley and C. A. Broaddus, all of Salt Lake City, Utah, attended Professor Fuchs' lectures in San Francisco.

Dr. Horace G. Merrill has resumed practice of the eye, ear, nose and throat, in Provo, Utah, after a year's absence for postgraduate study in eastern cities.

Dr. and Mrs. George N. Huber, of Coffeyville, Kansas, returned September 15th from three months spent in California, Pacific Northwest, and the Canadian Rockies.

Dr. F. J. Pinkerton, of Honolulu, is spending several months in the States. He will visit the large clinics and review some of the more recent work in eye, ear, nose and throat.

Dr. Edward Jackson read a paper before the Utah, Wyoming, Colorado Section of the American College of Surgeons, which met in Salt Lake City, September 12th, on "Ocular Muscle Transplantation."

Drs. Allen Greenwood, W. Holbrook Lowell, Frederick H. Verhoeff, Leon W. Jessaman, L. Maud Carvill, and John G. Jennings have removed their offices from 101 Newbury Street to 82 Commonwealth Avenue, Boston.

The Italian military authorities recently presented Dr. E. Trombetta and Dr. S. Santucci, ophthalmologists connected with the University of Turin, with an illuminated address and gold medal in appreciation of special services rendered.

Acting Assistant Surgeon Clarence E. Downes, head of the Trachoma Hospital at La Moure, North Dakota, has been succeeded by Acting Assistant Surgeon W. C. Thomas, head of the Trachoma Hospital at Pikeville, Kentucky. Dr. Downes will take Dr. Thomas' place at Pikeville.

Professor E. Fuchs of Vienna has been spending several weeks in Honolulu. He gave there two interesting lectures, one on the history of ophthalmology, and the other on the early diagnosis of arteriosclerosis of the retinal vessels. Both lectures were immensely enjoyed by enthusiastic audiences.

SOCIETIES.

Salt Lake has just entertained the Pacific Coast Oto-Ophthalmological Society, and also the Western Section of the American Laryngological, Rhinological and Otological Society. The meeting was of three days' duration, of which the latter named society occupied the last day.

Seventy-one specialists registered for the meeting, including Drs. W. L. Benedict, of Rochester, Minn.; Thos. E. Carmody and Edward Jackson, of Denver, as invited guests.

The society has a membership of over two hundred. For next year (1923) the following officers were elected: President, Dr. W. Humes Roberts, of Pasadena, California; first vice-president, Dr. Kaspar Pischel, of San Francisco; second vice-president, Dr. A. W. Morse, of Butte, Montana; and secretary-treasurer, Dr. C. Benson, of Los Angeles. The 1923 meeting will be in Los Angeles, probably a week before the American Medical Association Meeting in San Francisco the week of June 25–29, 1923.

The Minneapolis meeting of the American Academy of Ophthalmology and Oto-Laryngology held under the presidency of Dr. Walter R. Parker, of Detroit, was notably successful. Almost 400 Fellows of the Academy registered, and the attendance at the course of graduate instruction was about as large. The most notable guest was Professor Robert Bárány, of Upsala, who opened the discussion on Nystagmus, and presented a paper on "Modern Views Concerning the Labyrinth." For the ensuing year the officers elected were: President, Thomas E. Carmody, Denver; first vice-president, Hunter McGuire, Winchester, Va.; second vice-president, John A. Morse, Minneapolis; third vice-president, S. Hanford McKee, Montreal, Canada; secretary, Luther

C. Peter, Philadelphia; treasurer, Secord H. Large, Cleveland; editor, Clarence Loeb, Chicago. Members of the American Board for Ophthalmic Examinations: Edward Jackson, Denver, and Lee Mastin Francis, Buffalo. The committee on graduate instruction: W. P. Wherry, Omaha; H. S. Gradle, Chicago; E. C. Ellett, Memphis; and William R. Murray, Minneapolis.

MISCELLANEOUS.

A bequest of $2,000 has recently been made the Eye, Ear, Nose and Throat Hospital of New Orleans, by the will of William G. Vincent, on the death of Mrs. Vincent.

Construction work will soon be started on a new eye, ear, nose and throat hospital at Charlotte, North Carolina. The plans call for a four-story brick structure.

The ophthalmologic department of the Massachusetts General Hospital, Boston, announces the bequest of the principal of the estate of George D. Loud, eventually.

The National Committee for the Prevention of Blindness reports that wood alcohol, peddled as whisky, caused 130 deaths and 22 cases of blindness in twenty-one states during the first six months of 1922.

A school for the blind, the first of its kind in Armenia, is to be opened in Alexandropol, Armenia, by the Near East Relief, under the direction of Dr. R. T. Uhls, of Kansas City, Missouri. The pupils will be 150 Armenian war orphans, aged five to fourteen years. Most of them are victims of trachoma. It will be called the Cleveland House, because the city of Cleveland has provided funds for its maintenance.

Announcement of a gift of $20,000 each from Mrs. E. C. Gale and Mrs. Frank C. Todd, of Minneapolis, toward the construction of a $190,000 eye, ear, and nose hospital at the University of Minnesota, is made by A. J. Lobb, university comptroller.

Work on the new hospital, which is to be known as the Todd Memorial Hospital, will begin some time before July 1, 1923, Mr. Lobb said.

To the $40,000 gift of the two Minneapolis women, the university is adding $150,000. The hospital will specialize in ear, eye and nose diseases, and will furnish clinical work for medical students, as well as provide medical attention for residents of the state who are unable to pay for hospital care.

In the June number of the *Svenska Lakarsallskapets Handlingar*, published in Stockholm, the medal presented to Professor Allvar Gullstrand on his sixtieth birthday, by the Swedish Medical Association is reproduced, and the list of his works is given. A German translation of his long article on the simultaneous determination of refraction and visual acuity opens this issue of the *Handlingar*. A German translation is given also of his report of a case of keratoconus with pulsation in the cornea. Gullstrand was awarded the Nobel prize in medicine in 1911 for his contributions to ophthalmology, especially his form of slit lamp.

Dr. Uhls, who worked with the American Relief Commission in Armenia, just returned, says that this famine and terror stricken country is threatened with a new peril, trachoma, which is spreading so that all the population is endangered. In some villages all the inhabitants are suffering. Medical men are scarce and medicines to be had are in towns, in some cases hundreds of miles away. The position is desperate; the people have been undernourished for several years, and therefore their resistance is lowered. If more assistance does not come, in a few years all the population of Armenia will become blind.

Our French exchanges mention that the recent annual congress in France for the amelioration of the condition of the blind unanimously voted in favor of the Cantonnet-Nouet system of writing as a means of communication between the blind and the seeing. A resolution was adopted urging that this system be taught in the schools for the blind in addition to the Braille system. Cantonnet gives a fully illustrated description of his method in the Journal des Practiciens, 1922, v. 36, p. 520. It is printed like the Braille, with a punch, but the holes are made to correspond to the outlines of the letters, so that the words can be read at a glance. It does not take the place of the Braille, but supplements it for those who do not understand the Braille. J. A. M. A., 1922, v. 79, p. 977.

The Eyesight Conservation Council of America has elected a number of prominent educators to the board of councilors, following a recent visit of Dr. John J. Tigert, U. S. Commissioner of Education to Columbia University, where classes in eye conservation are being held this year for the first time. It is also establishing a special mailing list for lecturers and writers interested in the subject of vision. Data and material will be prepared and issued periodically to persons whose names are on the special mailing list. There is need for lecturers who will appear before local organizations, such as Rotarian and Kiwanis Clubs, chambers of commerce, schools and colleges, to present the subject of conservation of vision. The council states that in an examination of more than ten thousand employees in factories and commercial houses, 53 percent. were found with uncorrected faulty vision. In one manufacturing establishment, over 70 per cent. were found with eye defects. As an example of inefficiency and resulting waste, 20 percent. of the inspectors in a large factory were found to be unable to see sufficiently well to detect defects in the product they were inspecting. There are 42,000,000 gainfully employed in the United States, and over 25,000,000 handicapped by defective vision or eyestrain.

Current Literature

These are the titles of papers bearing on ophthalmology received in the past month. Later most of them will be noticed in Ophthalmic Literature. They are given in English, some modified to indicate more clearly their subjects. They are grouped under appropriate heads, and in each group arranged alphabetically, usually by the author's name in **heavy-face type.** The abbreviations mean: (Ill.) illustrated; (Pl.) plates; (Col. Pl.) colored plates. Abst. shows it is an abstract of the original article. (Bibl.) means bibliography and (Dis.) discussion published with a paper. Under repeated titles are given additional references to papers already noticed. To secure early mention, copies of papers or reprints should be sent to 217 Imperial Building, Denver, Colorado.

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Darlington, C. G. Value of Wassermann Test. Arch. of Ophth. 1922, v. 51, p. 493.

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Goerlitz, M. Tuberculin in Eye Diseases. Klin. M. f. Augenh., 1922, v. 68, pp. 306-323.

Howe, L. Coefficient of Thermal Conductivity of Eye and Orbit. (dis.) J. A. M. A., 1922, v. 79, pp. 936-939.

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